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YOUR EXPERT GUIDE TO TODAY'S TECH
NOVEMBER 2020 #486



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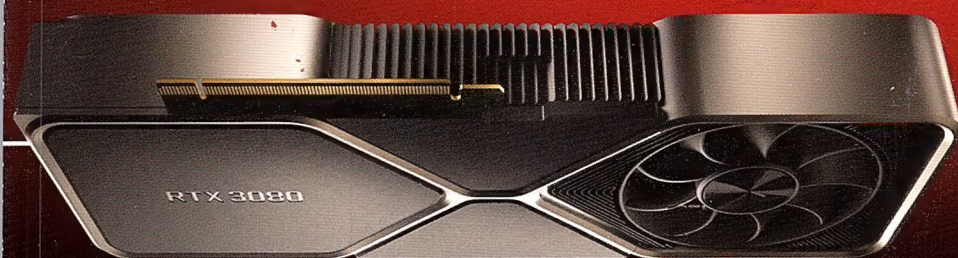
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STEP-BY-STEP ILLUSTRATED GUIDE



REVIEWED!
**Nvidia
RTX 3080**
A NEW ERA IN PC GAMING



GROUP TEST
**Money
savers**
CHROMEBOOKS & CHEAP
WINDOWS LAPTOPS

ARM INSIDE
WHY APPLE IS
DITCHING INTEL



ATTENTION
VIDEO
EDITORS!

**PREMIERE PRO vs
DAVINCI RESOLVE**
BATTLE OF THE BIG VIDEO
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**The perfect
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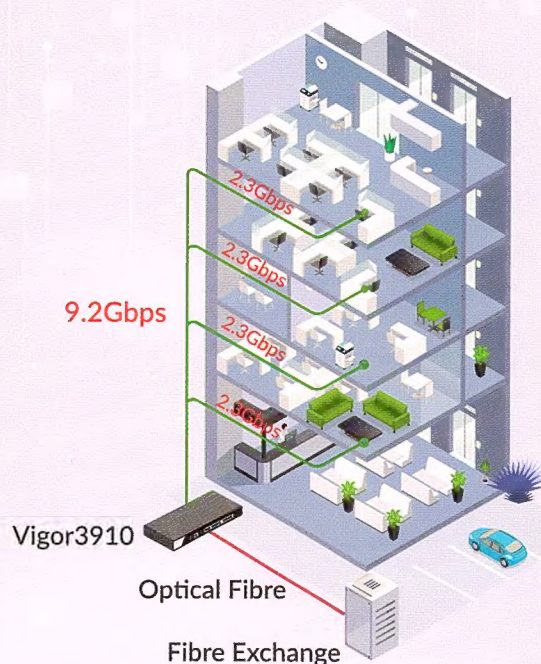


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EDITORIAL

Playing games

The loser shall not be Nvidia.

Some commiserations are due, this month. First, pity the poor reseller... when the new Nvidia RTX 3080 was announced it immediately rendered the 20-series cards unsellable. While it did take a couple of weeks before Australian pricing was known, the global launch – brought to us from Jensen's now-famous kitchen – included US pricing and that was enough to make it clear that not a single 20-series card would ever be sold again at full price.

Overnight pretty much every online store was forced to slash prices. Perusing most of them, I saw cuts of around \$300, typically. Today as I look around the price drop is more like \$1,000 or more for a 2080 Ti. Lordy. I don't personally

know exactly what the margin is for that particular product line, but it's fair to assume it's not 40 to 50 percent, which is the discounting we're seeing now that local pricing of the 3080 has been revealed.

We've reviewed the MSI RTX 3080 Gaming X in this issue. It has an RRP of \$1,469. That means a 2080 Ti needs to sell for *at least* a couple of hundred bucks below that – which is exactly what's happening. It's a long way to fall from the pre-3080 prices of up to \$2,400.

The 'partner' manufacturers must also be seething, as all 20-series inventory must now be discounted massively.

And, of course, the customers that bought one in

the days and weeks prior to the 30-series reveal must be wishing they'd waited. I'm sure the returns departments at shops have been having some very interesting conversations with recent buyers.

But who saw this coming? Not APC, that's for sure. Given the 20-series' bad rep for its record-breaking pricing we all expected the 30-series to be more sanely priced, but the degree to which Nvidia backtracked on making its stuff super-expensive took everyone by surprise.

Ultimately it's good news, and the RTX 3080 has turned out to be pretty fantastic, as Chris discovers in his review starting on page 28. While unlikely, there's also the possibility AMD's very soon to be released Big Navi graphics card may create a second round of buyer's regret. But that's tech. You can't wait forever...

BEN MANSILL



It's APC's issue number 486 – so we're marking the occasion with a nice feature story all about the Intel 486 CPU on page 52!

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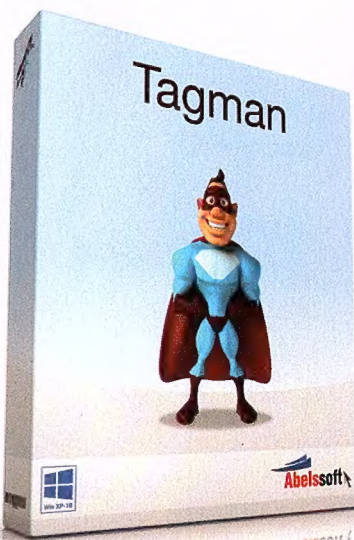
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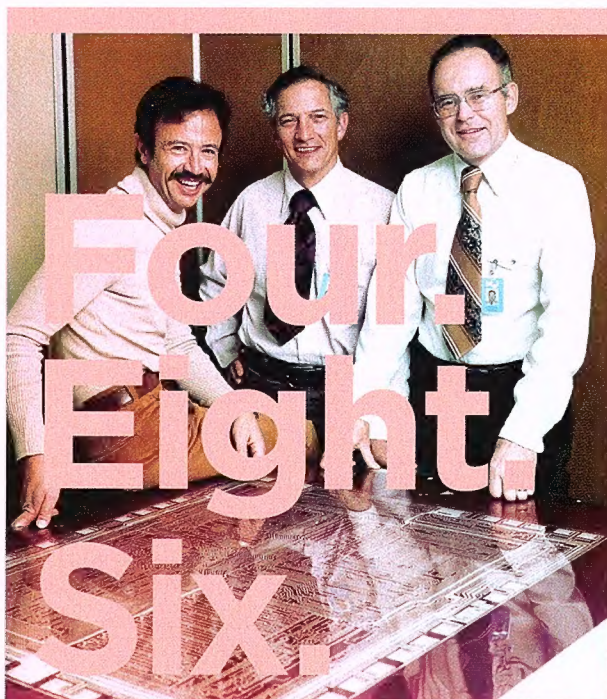
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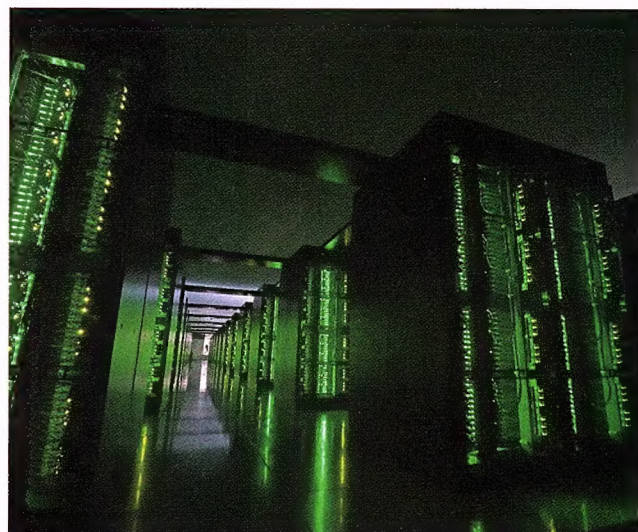
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STEP-BY-STEP ILLUSTRATED GUIDE **Page 82**



It was the first mainstream CPU to hit the one million transistor mark and marked a huge turning point in PC performance at the time **Page 52**



ARMing THE WORLD

Apple is dumping Intel processors for its own ARM-based designs. Will the traditional PC be next?

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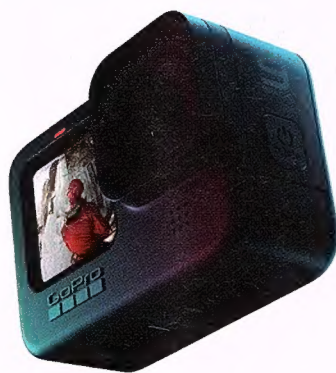


“Under full load, the cooler cannot be heard above the sounds of our AIO cooling fans or even the sound of the pump. Unless you have an airflow restricted case, we’re confident in saying that this MSI won’t be distracting you during your gaming sessions.”

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Huawei MateBook 14

Huawei's back with another affordable ultrabook, but is it enough to stand out in the competitive flagship laptop space?

Huawei's MateBook 14 scored full marks when we looked at it last year, and with new 10th gen Intel CPUs, improved display panels and a bigger battery, everything looks in place for this to be another impressive offering. The most obvious difference is the new 14-inch screen, which retains with the same 2160 by 1440 pixel resolution as a 2:1 aspect ratio that is good for viewing web pages. At 200 nits it isn't the brightest screen available, but it's bright enough for general work tasks and media playback when cranked right up. The screen also has a decent 90% screen-to-body ratio with 4.5mm bezels on the top 3 edges and a 1mm bezel on the bottom (the MateBook Pro X is dropping the bezels in a pop-up bezel design).

The chassis looks and feels like steel, but even though the manufacturer has been updated to offer a number of classic finishes, the overall design is starting to

look a little dated next to today's leading ultrabooks. Sadly there's no Wi-Fi 6, even though it's picking 10th gen CPUs and one of the 2 USB Type-A ports is USB 2.0 for extra storage, which makes it less than ideal for transferring data with a fast speed of 100MB/s. And while the new gesture controls and HiDPI ports are welcome inclusions, we can't help but feel that more established vendors have taken over the market already, or moved to more advanced solutions some time ago.

The MateBook 14 is using an Intel Core i7 10750H CPU, a Nvidia GeForce MX250 GPU and 16GB of RAM, which makes it functionally identical to the MateBook X Pro, except with a more powerful graphics card. This makes it a powerful work device that's ploughed through some people's workbooks and saved up to 10% of today's best ultrabooks. While this

chip isn't any more powerful than what you get on the MateBook 13, new CPU tests show up to 22% improvement in PCMark 10's overall work benchmark. Like a's predecessor, the CPU also gives a steady 100% for solo 1080p gaming. The can get playable 30fps frame rates in titles like Final Fantasy XV and Shadow of Mordor.

Shadow of Mordor, if you use the settings to low, but you'll probably want to drop a full frame 1080p resolution to ensure stability. The chip we can see, either due to the screen, that makes this device less expensive than the MateBook X Pro is the bigger form factor. At 1.1kg and 15.9mm thick the MateBook 14 is just 9.6 percent and 13 percent bigger than its flagging sibling, respectively.

Which isn't a big deal when you consider the price difference. Even the battery was almost identical at 50Wh, which has several more hours in media playback and about 10 hours in intensive workloads. So there's not a huge difference between this device and a \$900 more expensive MateBook X Pro. That said, we're in the price bracket of a similarly specced Microsoft Surface Pro 7, Acer Swift 5, Lenovo Yoga Pro 13, or an MSI Prestige 14 - all of which we've got ahead of the MateBook 14.

APC'S VERDICT
A powerful ultrabook with a little extra GPU horsepower for light gaming and decent battery life. ★★★★★

Legend: indicates score

	Huawei MateBook 14	Huawei MateBook 13
PCMark 10 (overall)	2804	2376
Cinebench R20 (multi-core)	708	720
Media 1080p (1080p)	18.662	17.14
3DMark Fire Strike (score)	3761	3782
Battery life (video playback, hours)	10:00	10:20
Peak CPU temperature (°C)	75	75
CPU/GPU Peak Power (W)	2.852	2.852
CPU/GPU Peak Power (W)	2.852	2.852



APC HOT PRODUCT
When a reviewed product scores 4.5 out of 5 or higher, it carries the Hot Award. These are products that exceed expectations and deliver a quality experience with there with the very best.



APC RECOMMENDS
You will see this award if a reviewed product has scored four out of five stars. It means most people can expect satisfying performance from the product, and that we would use it ourselves.

Inside APC

Find out all about APC's editorial policies, test practices, how to read the benchmark results, and more.

APC is Australia's oldest consumer technology magazine – having been consistently in print for forty years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech, too, from smartphones and apps to peripherals, accessories, and beyond. We have two goals: to find the best modern tech and to help you make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And, like you, APC's journalists want to know what's good in tech – no matter what platform it resides on.

Independent reviews

Championing technology doesn't mean we're unrelenting yes-men and -women, however, and APC aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three attributes.

As a matter of policy, reviews published in APC are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an APC reviewer has any potential conflicts of interest involving a

brand, the review will always be assigned to another writer.

Labs testing

APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance including storage read and write speeds, gaming and battery life.

In most cases, for the benchmark results published in APC, you can assume that higher is better. There are certain tests that deviate from this rule where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter offers better ease-of-readability, but tables are more compact, so we use these in most cases where thoroughness is preferred.

“APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible.”



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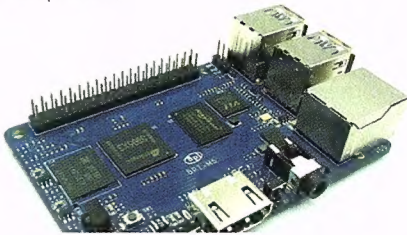
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Apple reveals 5nm A14 Bionic SoC on new iPad Air

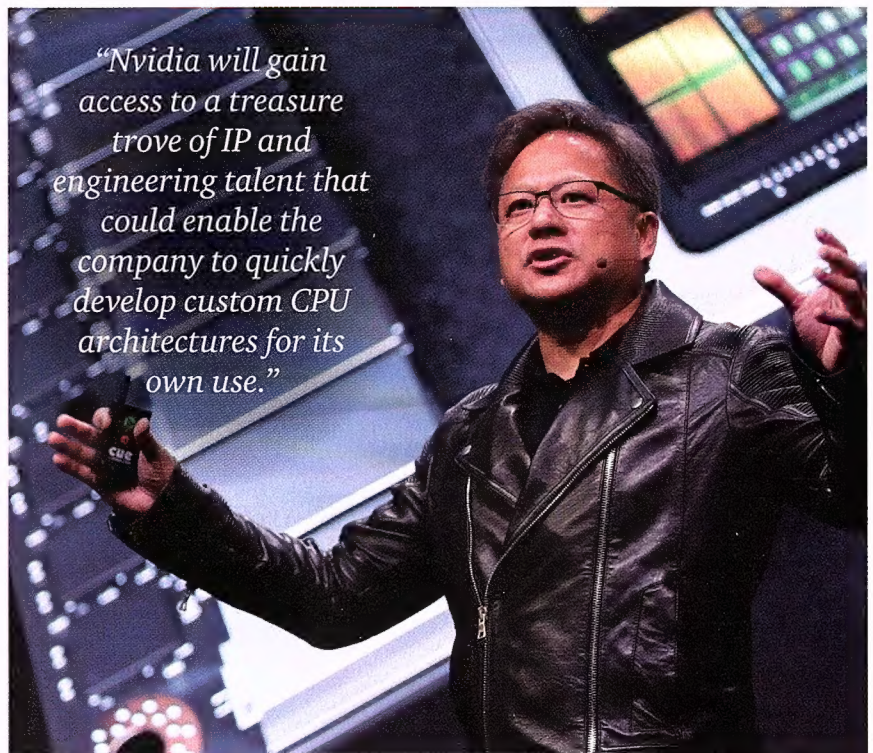
Apple has unveiled its latest internally-developed silicon, the A14 Bionic. It's built on a 5nm processor and has six CPU cores, four GPU cores and a 16-core neural engine. The chip will debut in the new iPad Air, which will go on sale in October.

The SoC has 11.8 billion transistors, which Apple said was quite the challenge, considering you're getting into measurements made in atoms. The CPU's six cores are broken into four high-efficiency cores and two high-performance cores. Apple claimed the offering is 40 percent faster than the previous generation and that graphics, via four cores, are 30 percent faster. Apple's neural engine has 16 cores for 11 trillion operations per second, and, for the first time on iPad, is paired with a machine learning accelerator for matrix multiplication.



Banana Pi BPI-M5 aims to take a slice of the Raspberry Pi 4

An interesting new player in the Single Board Computers (SBC) scene is the Banana Pi BPI-M5, offering the power of the Raspberry Pi 4 with onboard eMMC flash storage. The Banana Pi BPI-M5 has at its heart an Amlogic S905X3 System on Chip which features an ARM Cortex-A55 processor running at 2GHz and a Mali-G31 MP2 GPU running at 650MHz. RAM comes in the form of a single chip of 4GB of LPDDR4, so is mid-range when compared to the three memory options for the Raspberry Pi 4. What is most welcome is 16GB of eMMC flash storage soldered to the board, with options available for models featuring up to 64GB of eMMC.



"Nvidia will gain access to a treasure trove of IP and engineering talent that could enable the company to quickly develop custom CPU architectures for its own use."

CPU NEWS

Nvidia announces ARM acquisition for US\$40 billion

Biggest chip deal ever.

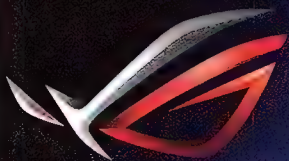
After months of speculation and reports, Nvidia announced that it is acquiring ARM Limited from SoftBank in a transaction valued at US\$40 billion. SoftBank "will remain committed to ARM's long-term success through its ownership stake in Nvidia, expected to be under 10 percent," signaling that Nvidia will gain full control of ARM. However, the transaction does not include ARM's IoT Services Group, which remains with SoftBank.

The deal ranks as the largest semiconductor acquisition in history and marks the second-largest tech acquisition in history, behind Dell's US\$64 billion purchase of EMC. As expected, the ARM/Nvidia deal will be subject to regulatory approval and could take up to 18 months to finalise. ARM's current licensees include industry leaders like Apple, Qualcomm, Amazon, and Samsung, among many others, and it remains to be seen how those companies will react to the acquisition.

Nvidia stated that it would remain committed to ARM's open licensing model and customer neutrality, all while expanding ARM's IP licensing portfolio with Nvidia's GPU and AI technology. According to the press release, ARM licensees have already shipped over 180 billion chips based on the ARM architecture (22 billion in the last year), making the addition of Nvidia IP to that portfolio an enticing proposition.

ARM's intellectual property will also remain registered in the UK, and Nvidia will "retain the name and strong brand identity of ARM." ARM will remain headquartered in Cambridge, UK, and Nvidia announced that it would expand ARM's R&D presence there with a new AI research and education centre that will house an ARM/Nvidia-powered AI supercomputer for research.

Nvidia will gain access to a treasure trove of IP and engineering talent that could enable the company to quickly develop custom CPU architectures for its own use, which would then further the company's broadening push into the profit-rich data centre market. Nvidia has already paved the way for ARM integration with its GPUs through the recent introduction of CUDA support for ARM architectures, and now the company will have control of the underlying ARM ISA, too, enabling extremely tight integration into its solutions.



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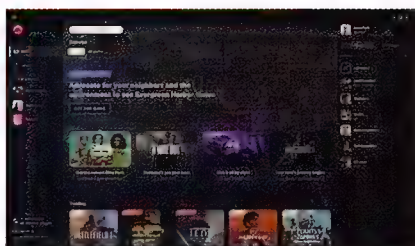
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EA introduces a new EA Desktop app to replace Origin

EA is underway with a company-wide rebranding that dropped the Access and Origin names in favour of EA Play, before expanding EA Play to Steam and then even including EA Play in Xbox Game Pass Ultimate at no additional cost. Now, EA has announced that it's working on an all-new desktop application appropriately named the EA Desktop app, which has been built from the ground up to offer a much faster, better looking, and easier-to-use experience than the older, and often criticised, EA Origin software.

The EA Desktop app promises to include overall faster performance and a less cumbersome UI, along with PlayTime controls to monitor how much time is spent in games, including friends and family, and, most importantly, Dark Mode.



Oculus Quest 2 revealed

The new device is 10 percent lighter than the first Oculus Quest at 503g and with a 50 percent sharper LCD screen (1832 x 1920 resolution per eye) than its OLED-based predecessor, it comes with an improved processor (the Qualcomm Snapdragon XR2, which will allow the screens to run at 90Hz), more RAM (up from 4GB to 6GB), controllers with twice the battery life and room for thumb rests, and built-in speakers and hand tracking.

Again, thanks to external sensors, there's no need for additional tracking stations or PC equipment, with everything powered by the Oculus Quest 2 headset itself. Expect two to three hours of battery life, charged over USB-C, depending on the VR software you're using.



CPU NEWS

Intel launches 11th Gen Core Tiger Lake

Up to 4.8 GHz at 50 W, 2x GPU with Xe, new branding

Tiger Lake will power Intel's next generation of notebook-class devices. These new 11th Generation Core processors use four of Intel's latest cores built with the Willow Cove microarchitecture – a slightly modified version of the Sunny Cove microarchitecture found in Intel's 10th Generation Ice Lake processors.

These new cores offer more performance than before, peaking at 4.8GHz compared to the 4.0GHz seen in the previous generation, a 20 percent improvement. However the underlying clock-for-clock performance improvements are minimal, with Intel instead focusing on that frequency gain.

The reason for the frequency gain comes from the manufacturing process – formerly Intel's 10++ process, renamed once to 10+ and then again during Intel's recent Architecture Day to its new name: Intel's 10nm SuperFin technology. The goal with this manufacturing process was two-fold: firstly to increase efficiency and scalability to enable higher frequencies, but also to improve yields. As a result, we will see Intel claiming higher frequencies, that lead to higher performance, at similar power levels to the previous generation.

These cores support AVX-512, as well as Intel's DL-Boost acceleration libraries.

On the graphics side, Tiger Lake uses Intel's new Xe-LP graphics architecture, which the company also detailed at Architecture Day. Simply put, Xe-LP increases the raw thread count and compute count per execution unit (EU), as well as the cache hierarchy and some acceleration features. For Ice Lake we saw 64 EUs running at 1100MHz, whereas for Tiger Lake we will see 96 EUs (+50 percent) running at 1350MHz (+22 percent). Add in some of the other benefits and we should supposedly see a 2x improvement in graphics performance compared to the previous generation on paper.

For AI compute, the graphics also supports DP4A instructions for INT8 inference workloads.

The graphics display pipeline has been improved, with support for AV1 decode, as well as display pipes for up to four 4K60 displays or a single 8K60 display. Other improvements to Tiger Lake include native Thunderbolt 4 support, with the controller embedded into the CPU allowing for up to four TB4 ports per device. Wi-Fi 6 support is also enabled through a CNVi interface.

Introducing 11th Gen Intel® Core™ Processor

New Willow Cove Cores Up to 4 Cores / 8 Threads Up to 4.8GHz		New Iris™ Xe Graphics Up to 96EU – Up to 2x Higher Performance Intel® Deep Learning Boost: DP4A for AI
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New Memory Controller LP4/x-4266 4x32b up to 32GB DDR4-3200 2x64b up to 64GB		New 4 x Display Pipes Up to 1 x 8K60 or 4 x 4K60 DP1.4 HDR3, BT.2020
1st Integrated Thunderbolt™ 4 Full 4x DP/USB/PCIe mux on-die Up to 40Gbps bi-directional per port		New Image Processing Unit (IPU6) Video up to 4K90 resolutions (initially 4K30) Still image up to 42 megapixels (initially 27MP)
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TECH BRIEF

Intel makes it official: eight-core Tiger Lake chips coming

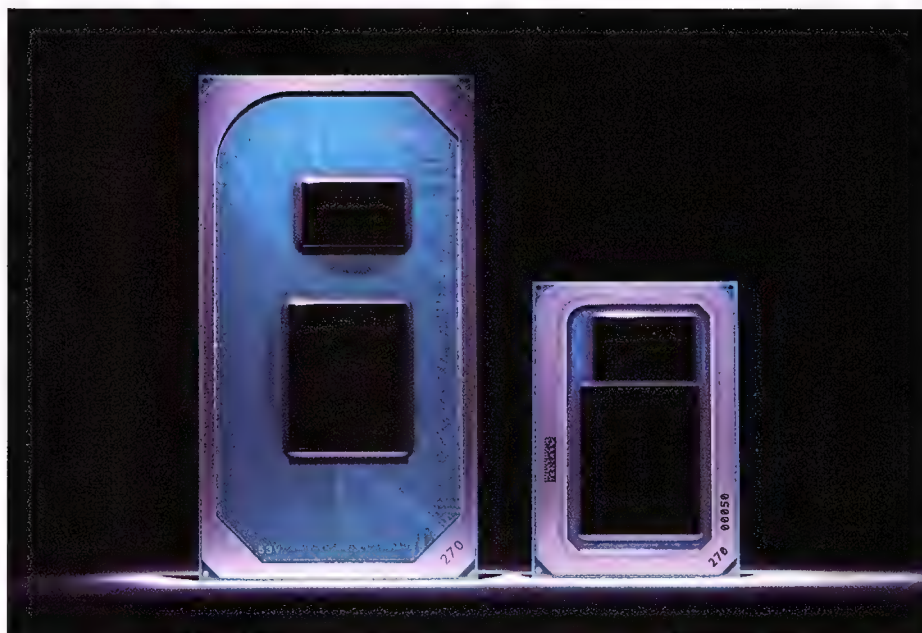
Filling up Tiger Lake.

Intel's slow trickle of information on its Tiger Lake processors recently turned into a veritable flood as the company shared information about its first salvo of 10nm SuperFin chips, but one detail was missing: Any official disclosures of chips with more than four cores. That changed in a decidedly low-key way, as a blog post from Intel fellow Boyd Phelps on *Medium* reveals that the company will introduce eight-core models soon, saying:

"We also added a 3MB non-inclusive last-level-cache (LLC) per core slice. A single core workload has access to 12MB of LLC in the 4-core die or up to 24MB in the 8-core die configuration (more detail on 8-core products at a later date)."

Intel claims that its four-core Tiger Lake models, by virtue of their 10nm SuperFin Process, Willow Cove Cores, and Iris XE graphics, can already beat AMD's eight-core Renoir chips in some performance benchmarks. If Intel's performance projections for its quad-core models are accurate, the eight-core Tiger Lake models could prove to be exceedingly competitive against AMD's existing Ryzen Mobile 'Renoir' lineup, possibly even wresting away the lead in threaded applications. We've yet to see independent third-party verification of the quad-core Tiger Lake chips in reviews, but AMD's upcoming Zen 3 "Cezanne" APUs are now extremely important as AMD looks to keep its performance advantage in the laptop market despite the looming eight-core Tiger Lake models.

The current dual- and quad-core Tiger Lake chips address only



the 7 to 28W segment, while larger eight-core Tiger Lake-H processors would obviously tackle the upper echelons of the performance market, possibly stretching up to 45W models (~65W peak) for H-series Core i9 and i7 models.

We won't go into Tiger Lake's full technical details, but Intel's plans for eight-core Tiger Lake models aren't entirely surprising. Intel's current 10th-gen lineup includes 10nm Ice Lake processors that address the iGPU gaming market with up to four cores, while the 14nm Comet Lake processors slot in for high-performance productivity workloads. However, Intel told us during its Tiger Lake briefings that all of its future laptop chips will come with the 10nm SuperFin (or better) process, meaning the

company won't have a split product stack for its 11th-gen lineup.

Much of Intel's previous limitations on its Ice Lake models stemmed from the low clock frequencies and poor yields, both of which conspired to limit performance and core counts – Intel's best 10nm efforts thus far have resulted in quad-core chips for laptops. Intel's new 10nm SuperFin process has corrected the clock speed issues, we see up to a 700MHz increase to base and boost frequencies, and the emergence of eight core models imply that defect rates are lower, and thus yields are up, allowing Intel to punch out 10nm laptop chips with up to eight cores.

Intel has no plans to bring Tiger Lake to its lineup of desktop chips, but we have already seen the first new Tiger Lake NUCs emerge from Asrock. Naturally, eight-core Tiger Lake models will also work their way into the NUC lineups. Given their pairing with the Xe graphics engine, they could prove to pack a decent performance punch for compact desktop PCs. ■

"If Intel's performance projections for its quad-core models are accurate, the eight-core Tiger Lake models could prove to be exceedingly competitive against AMD's existing Ryzen Mobile 'Renoir' lineup, possibly even wresting away the lead in threaded applications."



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END USER

Xbox Series and PlayStation 5 show two different paths for the future of consoles

Microsoft wants you to subscribe, Sony wants you to play big budget games – Shaun Prescott asks which will win?

Consoles are changing. Microsoft and Sony are both releasing next-generation offerings in November, and as you'd expect the main selling point is the power they'll bring to the table: 4K is an advertised benchmark, ray-tracing will be supported, and more generally, everything will look prettier and run more smoothly – at least until the consoles start to grow long in the tooth.

But Sony and Microsoft are diverging in significant ways when it comes to their approaches to what next-gen means in 2020. At the time of writing, Sony is releasing one SKU, simply called the PlayStation 5, and the pitch isn't wildly different from the pitch that accompanied PS4: prettier games, first-party exclusives. This time a yet-to-be-specified degree of backwards compatibility will be supported with its predecessor, but Sony's focus is very much on why you buy a new console in the first place: it'll have games you can't play elsewhere. These include a new Spider-man game, the sequel to *Horizon Zero Dawn*, and a remake of cult classic *Demon's Souls*, among others.

Microsoft's approach is different. It's releasing two consoles: one of these, the Xbox Series S, boasts less impressive

hardware but is still 'next-gen' – it'll cost \$500 in Australia. Meanwhile the Xbox Series X is \$750, and offers the true next-gen experience.

The hardware is important, of course, but Microsoft is banking on drawing people into its subscription ecosystem. Xbox Game Pass offers over 100 games for around \$10 a month, ranging from blockbuster titles through to small indies. Meanwhile, Microsoft offers full backwards compatibility with Xbox One – no caveats – and a contract system which lets you pay off your console in monthly instalments, operated by Telstra in Australia.

But can Microsoft survive without big games? *Halo Infinite* was meant to launch alongside the new generation, but was delayed into 2021 due to a poorly received gameplay premiere in August. Of course, it owns *Minecraft* – but *Minecraft* is on PS4 and PC. Of course, it owns *Forza* – but the next *Forza* game won't be out for a while, and again, it's coming to PC too. Of course, Microsoft has been on a studio acquisition spree, with the likes of Obsidian and Inxile now under the Redwood company's umbrella. But new games from either of these are a long way off.



SHAUN PRESCOTT

Author, PC gamer and passionate technology observer, Shaun covers trending tech topics for APC.

Microsoft's strategy makes PC gamers happy: they get most, if not all, of Xbox's exclusives. Sony is starting to release its first-party games on PC (*Horizon Zero Dawn* released on Steam in July), but there's no way in hell its launch window exclusives will release in concert with any theoretical PC port. Microsoft wants an Apple-style iterative approach to hardware roll-out, with a Netflix-style subscription service as its core feature. Sony seems to want business as usual.

Both are strong strategies for a variety of reasons, and it's harder to tell who will "win" this generation than it was in the lead up to Xbox One and PS4's launches (Microsoft seemed to have no hope). But Microsoft's approach is worrying developers. Having to factor in the low base Xbox Series S console has elicited criticism from devs ranging from Remedy Entertainment (Alan Wake) through to Flavourworks (Erica). Not to mention the droves of fans and commentators worried that Series S compatibility will hold the generation back in its entirety. Microsoft took a gamble last gen, and it didn't work out for them. They're doing it again in 2020, and while it's definitely a lot more sensible, it could very well blow up in their face. ■

Nvidia, ARM and the AI revolution

Graphics behemoth arms itself with new fingers for the future's AI pies.

Jensen Huang, the Founder and CEO of Nvidia, framed the recent announcement of the company's purchase of ARM Limited as something that will make Nvidia the "premiere computing company for the age of artificial intelligence". At US\$40 billion dollars this transaction might seem like a hefty price for something that'll help the Google Assistant to realise you were actually talking to your dog. We kid, ARM Limited's processor manufacturing business alone is probably worth that price tag since you'll likely have some of its cores sitting in the smartphone you use every day, but Huang is right, Nvidia stands to make its investment back in a matter of years thanks to the expansion of

the AI market.

We like to cover the quaint progression of AI into fields like writing, medicine and surveillance, but AI is already the backbone of companies like Facebook. Machine learning is the only thing capable of delivering a customised selection of targeted advertising for each individual, a tool that allows Facebook to maintain the interest of its users and sell guaranteed impressions and conversions to the highest bidder.

For the uninitiated, Facebook's annual revenue was US\$70 billion dollars in 2019 and AI is the driving force behind the company's 11 percent year-on-year growth, so Nvidia would be well placed for an investment like this, even if



JOEL BURGESS

When not reviewing PCs for APC and writing our funny pages, Joel likes to ponder tech and how it's used.

Facebook was its only client. When you consider that since 2016 it's also been clear just how critical Facebook's AI has been in reshaping democracy by influencing the hearts and minds of selected swing voters for profit, Nvidia's positioning looks even smarter. So if Facebook and its AI tools are the modern kingmakers, we expect Nvidia backed programs like GPU-Accelerated AI shopping and politically funded election campaigns to pay off for the GPU manufacturer in a big way.

If that wasn't enough AI is also a major area of investment from businesses like Amazon Web Services and the Google Cloud Platform, which host AI server farms large enough to accommodate other businesses that experiment with machine learning applications. Again this might seem quaint, but add up the integration of AI in everything from coronavirus vaccine development to self driving cars and it's clear that the power of AI will underpin all of the next major tech breakthroughs... or at least the most significant ones.

There are some obvious synergies between ARM and Nvidia when it comes to AI at both the macro and micro scales. We joked about smartphone AI earlier, but dedicated AI processors have been baked into flagship phone SoCs for the last couple of years now, a feature that has powered major software advancements in voice recognition, real time image processing and photography enhancements.

Looking bigger, ARM servers for AI have been gaining a lot of recognition in both edge computing and the IoT space due to their size, cost and efficiency benefits, a direction that Huang pointed to directly in a statement about the acquisition. "In the years ahead, trillions of computers running AI will create a new internet-of-things that is thousands of times larger than today's internet-of-people." Every smart device or AI driven surveillance camera will need hardware, so Nvidia will have a healthy market for its ARM devices in the future... even if smartphone-sales have already peaked. ■

"If Facebook and its AI tools are the modern kingmakers, we expect Nvidia backed programs like GPU-Accelerated AI shopping and politically funded election campaigns to pay off for the GPU manufacturer in a big way."





TWO BITS

A truly golden year of tech

If you're a tech enthusiast, the rest of 2020 is as good as it gets.

What a time it is to be a PC enthusiast or a gamer! Between now and the end of the year we've got new GPU ranges from Nvidia and AMD and a new CPU platform from AMD. There's even the possibility of 11th Generation Intel desktop CPUs too, though they're likelier to arrive in early 2021. Oh, then there's the small matter of new Playstation and Xbox consoles! It doesn't get much better.

It all begins in this very issue with our review of Nvidia's all new RTX 3080. It redefines the top end of the GPU market, and it's not even the highest tier model! If you're a 4K gamer, use multiple screens or really want to test out that 240Hz monitor, it's the card to get – at least until the 3090 arrives on shelves! Don't forget the likes of the 3070 and 3060 too. These could really shake up the market.

But what about the response from AMD? We've been expecting to see a 'Big Navi' ever since the launch of the RX 5700 series a little over a year ago. It's been teased and teased, and at the time of writing AMD had just revealed its design for a

new RX 6000 card. It's even being teased in-game in *Fortnite*, too. Is this new RDNA2 GPU enough to take on Nvidia's best? We can't wait to find out. Competition is great for all gamers, no matter whether you buy a card from team green or team red.

How about things on the CPU side? The dust has hardly settled on Intel's 10th Generation launch. They're strong gaming CPUs but they're an evolution of what came before. We're really craving a brand new architecture from Intel. 11th Gen models probably won't be the almost mythical 10nm CPUs we've been hoping for, but a new architecture on 14nm could still hold more than a few surprises. Perhaps will see more revealed in early 2021.

Before that, we're closing on the reveal of AMD's Zen 3-based Ryzen 4000 series CPUs and the



CHRIS SZEWCZYK

A life-long PC tech enthusiast, Chris has worked across the industry in many areas as a product and technology expert.

accompanying X670 motherboard platform. These CPUs are brand new and built from the ground up. AMD is teasing a reveal in October. Will these chips allow AMD to pull ahead of Intel in terms of gaming performance? It won't be a stretch to assume they will be very very strong under multi-threaded loads.

APC might be a PC tech magazine, but that doesn't mean we aren't excited about the new consoles too. They're very PC-like consoles, too, built with AMD CPUs and GPUs that won't be all that different from those you'd buy off the shelf. Cross-play is becoming more widespread and they're using SSD technology as well. Gamers of all stripes should be excited by this console and PC gaming convergence. It means game developers won't have to use as many resources rebuilding their code to suit unique platform architectures.

2020 hasn't featured too many exciting moments in the PC space, but holy haberdashery, Batman, that's about to change! The back end of 2020 is simply chock full of tasty tech releases. We're excited, and we hope you are too! ■

"So, is it worth going for RAM at 4000MHz or even higher? Unless you're a competitive overclocker, the answer is no."

HOW IT'S DONE

TAKING THINGS APART AND HAVING A POKE AROUND



Razer Kishi

What's inside the bits you hold.

Razer's new Kishi Universal Controller is here to turn your smartphone into a play-anywhere system, with real buttons and joysticks. Join us as we tear down this stretchy controller to take a closer look at its inner workings.

Major tech specs

- Standard A-B-X-Y buttons, two clickable analog thumbsticks, one eight-way D-pad, plus a shoulder button and trigger button on each side
- Connectivity to a phone via USB-C or Lightning connector
- No internal battery, no Bluetooth, and no headphone jack
- Compatible with Android 8 Oreo/iOS 9 or higher, supporting device dimensions of 145.3-163.7mm (H), 68.2-78.1mm (W), and 7.0-8.8mm (D)

Key findings

- Two slide locks on the back of the Kishi secure both halves of the controller, keeping it compact when there's no phone attached. Pulling outward on both inserts releases the clip, so you can extend the Kishi until your phone fits in between.
- We blast off 10 tri-point screws

from the rear side. Thankfully we came equipped with 64 bits of Mako Driver Kit goodness. Beneath the back cover, we find two Steam-ish booby-trap interconnect cables – each one snaking off to a separate circuit board.

- Instead of the tri-points in other portable gaming options, we find Phillips #0 screws inside the handles. We're happy to go on a Phillips fetch quest. There's no boss battle here yet – just a couple of boards, which we quickly extract.
- On the back of the board is an ARM 32-bit Cortex-M0 CPU and breakout board for the second shoulder trigger, which is attached separately so is easier to repair. This one seems to use some sort of rotary knob, offering not only an on/off status but a gradual push depth of the shoulder trigger.
- Extracting the left circuit board reveals another joystick that is also soldered in place, four golden contacts for the D-pad (similar to the ones on the first circuit board), a soldered-on shoulder button, and a shoulder trigger breakout board. Gamevice has unmistakably left its mark here – in case you

The soldered-on joysticks are durable but a pain to replace.

The Kishi easily expands to accommodate your phone.



The Razer Kishi is a stretchy bit of tech to turn a smartphone into a play-anywhere system, complete with joysticks, shoulder buttons and triggers, and A-B-X-Y buttons.

wondered with whom Razer partnered up for this controller.

- What remains is the telescoping slider mechanism that supports the phone. It includes a folding rubber cushion that attaches to the back cover with small springs, which saves you from worrying about scratches on the back of your phone while gaming. All external faces of the controller can be separated from the electrical components, which will make individual paint jobs a breeze.
- Quest complete! Let's recap: Easy disassembly (with the right drivers); some danger of losing small components and buttons; no ability to save your progress, so finish your homework and take out the trash before you start.
- Repairability Score: 6 out of 10 (10 is easiest to repair). No adhesive was used, and components are attached with screws. The controller's relatively modular construction means that replacing most components will be simple. One of the most strained parts – the phone connector – is plug-in and easy to replace. Using two different types of screw – one of them being tri-point – is unnecessary and a bit annoying.

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THE LIST

The Most Bandwidth-Guzzling Apps

08 Apple Music

Apple Music 1 GB/hr

British company Uswitch recently revealed which apps are chowing down on the most bandwidth in homes under lockdown. Apple Music clocks in at number eight.



Disney Plus 1.5 GB/hr

Fun fact: Disney's new-on-the-block streaming platform uses 50% more bandwidth on average than Netflix, and 87.5% more than Amazon Prime Video.



SoundCloud 1.65 GB/hr

More complex features like embedded widgets and downloads, as opposed to streaming, means that SoundCloud is a bandwidth-intensive way to listen to music.



FuboTV 3 GB/hr

Sports-focused fuboTV offers dual streaming and Cloud DVR storage for high-definition livestreams of sporting events. And wow, it's hungry for data.



Tidal 1.27 GB/hr

Jay-Z's high-definition music-streaming service certainly demands more bandwidth than the likes of Spotify. Lossless audio and music videos are largely responsible for this.



iHeart Radio 1.65 GB/hr

Podcasts and live radio shows have evidently been popular in lockdown, and iHeartRadio (formerly known as Clear Channel) has been hogging the Wi-Fi a bit.



Nvidia GeForce Now 2 GB/hr

Game streaming is naturally a data-heavy process, so it should be unsurprising that Nvidia's hosted-environment gaming platform gulps down bandwidth like candy.



Google Stadia 4.5 GB/hr

Of course Stadia gets the number-one spot. Google's 4K-capable game-streaming platform is an absolute monster when it comes to bandwidth use, so we're not even remotely surprised. ■

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Epson EH-TW5700

Cast your smartphone screen on the wall with Epson's new FullHD projector.

Projectors are fun gadgets for when you have friends around and want to display stuff on a bigger screen, but most current projectors lack software that makes it easy to actually access any modern streaming content. Epson's new FullHD projector, on the other hand, offers baked in Google Chromecast functionality allowing you to easily share anything on your Android device or Chrome web browser with the projector.

With a maximum display size of 330 inches and 2,700 lumens of brightness to play with, there should be plenty of screen for any lockdown-sized group to gather around.



\$699.95 | gopro.com/en/au

GoPro Hero 9 Black

Screen, battery life, stabilisation and resolution all get levelled up.

GoPro has updated its flagship action camera to include a new forward facing screen, bigger rear display, increased battery life and 5K video capabilities. While this isn't quite as big an update as the Hero 8 Black update it is focusing on features that will be useful for those under lockdown conditions, like baked-in computer webcam functionality. If you are more inclined to capturing the great outdoors, GoPro has updated its market-leading digital stabilisation and horizon-levelling features so you'll have amazingly smooth footage, no matter what you're doing while filming.



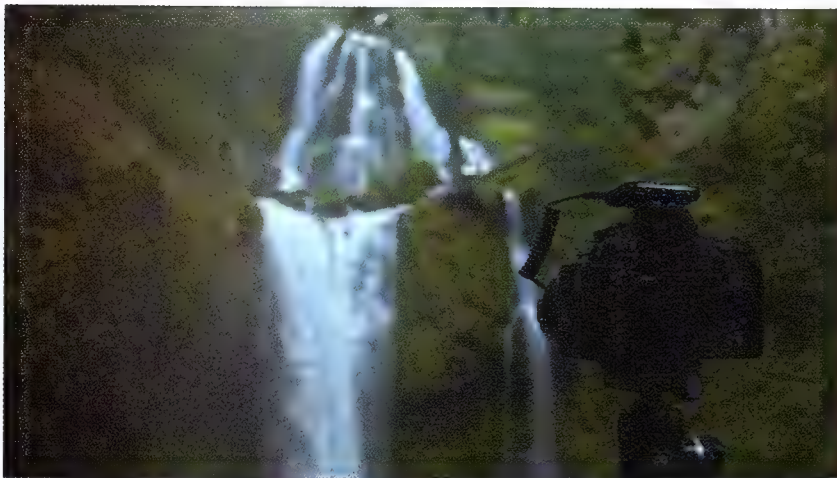
US\$199 | vueglasses.com

Vue Lite

The view to a smarter future.

Bose beat this company to the punch with its audio AR glasses, but after abandoning the project in June 2020 there's now space for startups like Vue Lite audio smart glasses. The original Vue Pro

Kickstarter went heavy on tech, but the new Vue Lite glasses supposedly weigh only 20 grams, which makes them a little more appealing for all-day wear. They also come in a range of funky spectacle and sunglasses shapes that look sleek and won't feel like a compromise. The glasses are connected to your smartphone via Bluetooth Low energy and are controlled via a touch interface on each arm or via voice assistant throughput.



US\$199 | kck.st/3aX6iKM

Arsenal 2

Upgrade your photography skills with an AI instructor.

The original Arsenal was a successful AI shooting assistant for DSLR and mirrorless cameras that helped users select the best settings for any particular context, but, as good as it was, we wouldn't have predicted Arsenal 2 would get close to \$4 million in crowdfunding support after just a few weeks. This revamp brings improved sensors and an updated AI algorithm to the DSLR attachment to mean it will find the best settings for a wide range of shooting scenarios. From what we can see Arsenal's star features are extracting colour in long-exposure photos, making giant panoramas and editing out people by stitching images together.



US\$795 | weret.com

Weret Surf Watch

Never miss a wave with weather info right on your wrist.

One of the leading surf report and weather forecasting tools, Magicseaweed, has teamed up with Swedish smartwatch producer Weret to make one of the world's first smartwatches designed specifically for surfers. If you are a keen boardrider then you'll know how conditions can change from unrideable onshore mush to clean solid groundswell in a matter of hours, and some of your best sessions will come from watching the weather closely. The Weret surf watches come with information on the tide, swell direction and intensity, wind direction and intensity, water temperature, air pressure and sunset time all baked into the analog watchface. It's even got a 100m waterproofing.



\$84.95 | belkin.com

Belkin Boost Charge Power Bank 10K + Stand Play Series

Game on the go with a bank full of power.

Playing games on your smartphone consumes a lot of battery, and while that's no issue when you have access to a charger, it means you can't really do it for too long when you're out and about. Unless, of course, you happen to have a battery bank. The Belkin Boost Charge Power Bank makes a pretty compelling argument with a 10,000mAh battery, 12W dual output USB connectivity and an inbuilt smartphone stand. The stand is a clever addition that makes it great for watching media or playing games, and it has an additional charging port, too. ■



"The 10980XE's lower heat generation and LGA 2066 socket allow for a wider range of possible coolers, and demonstrates better power and heat efficiency in mixed workloads."



HEAD TO HEAD

Intel Core i9-10980XE vs AMD Threadripper 3970X

Christian Guyton compares the king chips.

Value

At first glance, the Threadripper dominates here. The i9-10980XE is currently priced at \$1,999. The price will no doubt drop, but the 3970X is available at the time of writing for \$3,329, placing it below the 10980XE in terms of price-per-core. The Threadripper also has higher base memory support and more cache memory.

One imagines that the high prices we're seeing right now could be tied to COVID-triggered production issues, or general stock shortages, or simply a price hike for Intel to capitalise on lockdown demand. If we consider that sub-two-grand price point, the 10980XE looks a lot more reasonable. The 3970X, on the other hand, is a newer chip that isn't likely to see a significant price drop anytime soon. It looks practically affordable next to the comically expensive 3990X, which is currently priced at \$6,499, but it's still a crazy amount of money to spend on a processor. Neither of these CPUs are truly good value, but nothing in the HEDT sphere is right now. It's tricky, but assuming you actually can find a 10980XE for

closer to \$1,500, Intel wins.

Winner: Core i9-10980XE

Performance

We'll break this down into professional workloads and gaming workloads. Both chips excel in each area; when you're spending this much money, you'd expect as much. The Threadripper has a clear edge in productivity tasks, beating the Intel competitor in just about every area. 3D rendering, video encoding, file compression, you name it: the 3970X is a beast with its 64 threads. The 10980XE might perform better in specific benchmarks, but on the whole the Threadripper is simply more powerful.

Gaming is a different story. Yes, the 3970X is still better, but it's a far less dominant lead. Intel actually demonstrates better performance in some games when using the same GPU, and the AMD processor generally doesn't provide more than a few fps extra in most titles. Of course, neither of these are CPUs anyone should be buying exclusively for gaming – direct your funds towards a powerful GPU instead for that

– but plenty of systems are multipurpose. If you're a videographer, why keep two powerful PCs around for work and gaming, when one could handle the lot? And in such a system, the Threadripper is going to win out over Intel's "Extreme Edition" chip. Round 2 goes to AMD, although it's a close one.

Winner: Threadripper 3970X

Features

Both of these processors have a lot to offer. Both provide quad-channel memory support up to 256GB, and both utilise proprietary technology to double up on threads (that's simultaneous multi-threading for AMD, and Hyper-Threading for Intel). The Threadripper offers EEC memory support, unlike the XE, but this is a niche benefit; EEC memory is often slower than conventional DDR4, and isn't widely available for individual consumers.

The 3970X has one big point in its favour against the 10980XE, and that's PCIe 4.0 support. That means it can interface with ultra-fast 4th-gen M.2 SSDs, and the 3970X can also handle more active PCIe lanes: 64 as opposed to



"The Threadripper has a clear edge in productivity tasks, beating the Intel competitor in just about every area."

48 on the Intel chip. The 10980XE has superior overclocking potential, but these are both professional-grade workstation CPUs, so anything beyond auto-overclocking is risky. Intel Turbo Boost and Deep Learning Boost are welcome additions, but like EEC RAM support on the 3970X, the latter is niche.

If you're confident the Intel chip better suits your workloads it'll do great, but the Threadripper offers wide-reaching benefits. The 3970X's massive amount of onboard memory (144MB cache) makes it awesome at multitasking too.

Winner: Threadripper 3970X

Efficiency

Okay, AMD loses this round. Sorry to burst your bubble, Team Red, but the Threadripper 3970X has a TDP of 280W, as opposed to the i9-10980XE's comparatively subtle 165W. Yes, that's still a lot, but the 3970X draws so much power it could never hope to win this round. Use of this processor mandates a high-powered PSU, which will cost more initially and over time. The 10980XE is no slouch when it comes to power

consumption (note that TDP and power use are only indirectly connected), but a 600W power supply should do the job.

It's not just about power, either. The Threadripper generates a lot more heat during heavy use than the 10980XE, effectively forcing you to spring for liquid cooling, be that a high-end AIO or a custom loop. The mounting bracket for coolers hasn't changed from TR4, used by 1st and 2nd-gen Threadripper CPUs, but many coolers don't come with an sTRX4-compatible bracket, or require one to be purchased separately. The 10980XE's lower heat generation and LGA 2066 socket allow for a wider range of possible coolers, and demonstrates better power and heat efficiency in mixed workloads anyway. It's a smaller chip with fewer cores, so this was hardly a surprising result. Intel wins.

Winner: Core i9-10980XE

Professional support

This category is an important one when discussing HEDT parts. These chips are primarily used by enthusiasts and industry professionals, be they creatives or

number-crunchers, so manufacturer support is vital. Both processors offer three-year limited warranties, but what about customer service?

We took to consumer feedback sites to gauge the general response, since we typically deal with tech companies through their corporate PR teams. While both AMD and Intel theoretically offer full refund-or-replace services for faulty parts, anyone who has found a component dead on arrival will be familiar with the murky underbelly of RMA support. It seems from customer reviews that experiences are strongly mixed for both companies. One website listed aggregated user scores for Intel and AMD at 3.0 and 3.1 respectively. However, a read-through of the reviews under Intel revealed a lot of people angrier at processor performance than customer service, whereas we found no end of ticked-off AMD customers struggling to return dodgy parts.

It's a close one, but we're going to give the win to Intel. They've got more cash to throw around and more experience when it comes to consumer CPUs.

Winner: Core i9-10980XE

And the winner is...

The Intel Core i9-10980XE takes this one, but only by a hair. There's a pretty big caveat hanging over this victory, though: If you can't find a 10980XE for less than \$2,000, the Threadripper 3970X becomes the superior choice.

Both chips have their benefits. The huge generational price drop on the 10980XE was unexpected – welcome for sure but evidently not reliable, as some retailers are currently asking for north of \$2,000. Neither processor comes with a cooling solution included, which is unsurprising given that more powerful aftermarket cooling is a must-have here. Both can dominate in multi-core and single-core workloads, with a slight edge to Intel in single-core performance and a heavy lead for AMD in multi-core tasks. But 32 cores will do that; it's not a failing on the XE's part, the Threadripper merely exists on a higher level of physical design. It's far larger than the Intel CPU, and demands a pricey new TRX40 motherboard for full operational capability. Intel wins today, but secretly? This might be a tie. ■

\$1,469 | www.msi.com

RTX 3080. The next gen.

Hold onto your hats ladies and gentleman! The launch of a new generation of Nvidia graphics cards is always a major event, and here it is with **Chris Szewczyk** in the Labs.

The GeForce RTX 3080 is the lead card of the brand new Ampere range. It's joined by the RTX 3090 (a consumer level Titan replacement) and soon the RTX 3070 and RTX 3060. Ampere cards incorporate everything great about the Turing architecture and improve on it. The RTX 3080 is faster in games, offers better AI performance, it packs in cutting edge technology support and features improved ray tracing capabilities. If Turing served as a teaser of the possibilities of ray tracing, the Ampere generation may be the one that elevates it from a technology with potential into one that becomes as commonly enabled as anti-aliasing or anisotropic filtering.

What's under the hood
At the heart of the RTX 3080 lies the GA102 GPU. This is actually the same GPU as the one that powers the RTX 3090, but with one of the shader clusters disabled. The 3080 packs in 8,704 CUDA cores vs the 4,352 of the outgoing RTX 2080 Ti. 10GB of brand new GDDR6X memory ticks along at 19Gbps, up from the 14Gbps of the 2080 Ti. The GPU is built with Samsung's 8nm process, a surprise in itself when TSMC has long been the preferred supplier of Nvidia GPUs. The GPU crams 28.3 billion transistors into its 628.4mm² package. This is a very large and complex GPU. If by chance you're thinking about SLI, don't. Only the RTX 3090 supports it.

SPECS

MSI GeForce RTX 3080 Gaming X Trio; 8704 CUDA Cores; 1815 MHz Boost Clock; 10GB GDDR6X 19Gbps memory; 760 GB/s Memory Bandwidth; 3x Display Port 1.4, 1x HDMI 2.1; 3x 8-Pin Power Connector, 340W TDP.

The Ampere architecture contains improved Deep Learning and AI technologies. Deep Learning Super Sampling 2.0 (DLSS) uses details from multiple frames in order to produce an image. Rather than forcing the GPU to render every displayed image, the rendering burden is lessened. With the improved performance of the Tensor cores, Nvidia claims that 8K gaming is well and truly possible on Ampere graphics cards. To game at 8K, you need improved display support, and the RTX 3080 has it.

HDMI 2.1 is now included, which means support for 8K 60Hz or 4K 144Hz displays. There's PCI Express 4.0 support and upgraded video capabilities including AV1 decode support. The Founders Edition

incorporates a new 12 pin PSU connector, though for now the Founders cards are the only ones we've seen supporting this connector. The MSI RTX 3080 Gaming X Trio we're using for this review uses standard 8 pin power connectors (three of them actually!) The MSI includes a single HDMI 2.1 port and three 1.4a DisplayPorts.

One of the really interesting new technologies introduced with Ampere is RTX IO. This is a toolset that utilises the GPU to accelerate storage performance including things like improving game loading times and file compression. The upcoming consoles are expected to use something similar so this is a tech to keep an eye out for once games begin to incorporate it.

In addition to cutting edge hardware, Nvidia is also introducing new software tools and applications. One of these is Nvidia Reflex, which aims to reduce total system latency. Competitive e-sports is big business and improving the responsiveness and latency of a system beginning with a mouse click and ending with an action on screen is the goal. With refresh rates reaching 360Hz and higher, milliseconds count.

Pricing and performance
Australian pricing (quoted pre-release) seems to be quite reasonable. The MSI RTX 3080 Gaming X Trio has an RRP of \$1,469. This compares to \$1,139 for the Founders Edition. These prices may prove to be optimistic if initial demand greatly outstrips supply. Having said that, it's important to remember that people were asked to pay over \$2,000 for the top tier 2080 Ti's so to have a card that's much faster while



MSI's cooling solution uses its proven Tri Frozr triple-fan array, while the Founders Edition has a new and unique twin-fan design.

"The GPU crams 28.3 billion transistors into its 628.4mm² package. This is a very large and complex GPU. If by chance you're thinking about SLI, don't. Only the RTX 3090 supports it."

costing 25 percent less is something that Nvidia and partners deserve credit for.

The only real downside is the jump in power consumption. While the performance per watt is better compared to the last generation, we can't get used to a new normal where graphics cards pull close to 400W. We are at the limit. Where do graphics cards go from here? 450 or 500W? Four slot coolers?

Please let this be the ceiling!

Now that we've gone over some of the tech and features introduced with Ampere and the RTX 3080, let's jump into a look at a card. You might ask, why aren't we covering the RTX 3080 Founders Edition? We were planning to up until the last minute, but sadly Covid continues to wreak havoc with courier services and it didn't arrive in time before we went to print.

We're up to HDMI 2.1 now, and DP 1.4a for connectivity, though exact configurations will vary depending on the model.



Keep an eye out for that and 3080s from other vendors in our next issue! We thank MSI for stepping up and sending through its first 3080 card quickly so we could get our initial tech and architecture review in this issue for you.

MSI RTX 3080 Gaming X Trio

MSI graphics cards are typically very capable and come with a solid

reputation, particularly the high end Twin- and Tri Frozr-equipped models, along with its strong PCB designs. The RTX 3080 Gaming X Trio appears to be another top quality entry by MSI. It's a big, beefy card that takes up three slots. The cooler fins and fans have been redesigned. The fans themselves have pairs of blades connected at the ends for improved static pressure. The heatsink fins

are waved for improved dissipation properties and the GPU heatpipes are squared off for maximum die contact. Even the attractive backplate has an embedded heatpipe. And, it's been infused with graphene! We're starting to get the feeling that the RTX 3080 needs some serious cooling. There's also a nice little RGB light bar that can be controlled via MSI's Mystic Light app.

RTX 3080 BENCHMARK RESULTS

Indicates best result

	Metro: Exodus						F1 2020					
	1920x1080 Ultra Preset		2560x1440 Ultra Preset		3840x2160 Ultra Preset		1920x1080 Ultra Preset		2560x1440 Ultra Preset		3840x2160 Ultra Preset	
	Min	Avg	Min	Avg	Min	Avg	Min	Avg	Min	Avg	Min	Avg
MSI GeForce RTX 3080 Gaming X Trio	64.2	132.2	89.2	109.1	46.1	71.0	180	324	161	183	110	131
Nvidia GeForce RTX 2080 Ti	55.4	108.6	51.1	85.4	35.1	54.1	171	200	141	161	88	98
Nvidia GeForce RTX 2080 Super	48.5	90.0	42.7	71.6	28.9	44.7	150	175	120	138	75	84
Nvidia GeForce RTX 2070 Super	43.6	79.7	37.7	62.8	25.2	39.0	133	156	108	123	66	73
AMD Radeon RX 5700 XT	40.4	73.3	34.6	57.7	23.7	35.7	137	170	109	132	66	75

	Middle Earth: Shadow of War						Total War: Warhammer II					
	1920x1080 Ultra Preset		2560x1440 Ultra Preset		3840x2160 Ultra Preset		1920x1080 Ultra Preset		2560x1440 Ultra Preset		3840x2160 Ultra Preset	
	Min	Avg	Min	Avg	Min	Avg	Min	Avg	Min	Avg	Min	Avg
MSI GeForce RTX 3080 Gaming X Trio	30	130	37	154	30	83	158.9		130.1		107	
Nvidia GeForce RTX 2080 Ti	35	166	36	121	30	75	136.8		101.4		56.5	
Nvidia GeForce RTX 2080 Super	36	137	33	100	25	61	108.8		79.6		46.4	
Nvidia GeForce RTX 2070 Super	35	124	32	90	25	55	101.1		71.8		39.9	
AMD Radeon RX 5700 XT	33	116	28	78	22	47	89.7		61.9		32.9	

	Ghost Recon: Breakpoint						Shadow of the Tomb Raider					
	1920x1080 Ultra Preset		2560x1440 Ultra Preset		3840x2160 Ultra Preset		1920x1080 Ultra Preset		2560x1440 Ultra Preset		3840x2160 Ultra Preset	
	Min	Avg	Min	Avg	Min	Avg	Min	Avg	Min	Avg	Min	Avg
MSI GeForce RTX 3080 Gaming X Trio	60	126	60	105	58	71	165	197	123	161	74	80
Nvidia GeForce RTX 2080 Ti	60	107	60	86	46	56	129	164	94	114	54	63
Nvidia GeForce RTX 2080 Super	60	95	60	74	26	44	112	140	80	96	43	51
Nvidia GeForce RTX 2070 Super	60	88	56	68	27	39	101	127	70	86	38	45
AMD Radeon RX 5700 XT	59	90	54	67	15	17	98	118	67	79	35	41



Under full load, the cooler cannot be heard above the sounds of our AIO cooling fans or even the sound of the pump. Unless you have an airflow restricted case, we're confident in saying that this MSI won't be distracting you during your gaming sessions. There appears to be a hard limit of 350W for the whole card. Time restrictions prevented us from testing our sample cards with Nvidia's new power measurement tools, but we did record a full system peak power consumption of 487W. Bear in mind that's including an overclocked 10900K, plus fans and an AIO cooler etc. We consider that to be not too bad, though perhaps we too are becoming desensitised to high power consumption figures.

It's not just a quiet cooler, it's effective too. During a looping test at 100 percent load, the highest temperature we saw was just 69c. This allows the boost clock to stay at an insanely high level. At this temperature we saw fluctuations

MSI is moving away from bold colours in its products, using a very nice pure black for this, and leaving the owner to customise the look via RGB lighting.

between 1950MHz and as high as 1985MHz. That's well above the card's rated 1815MHz rated boost clock. Will some custom cards feature boost clocks above 2.0 GHz? Surely the answer is yes. Our 3080 Founders Edition may have fallen off the back of a courier truck somewhere in Australia, but we don't think it's a leap to assume that premium tier custom cards like MSI's will significantly outperform the Founders Edition in terms of noise levels, temperatures and importantly, the maximum boost clocks. We'd expect that though given the price premium.

Now we come to biggest question we all have. How does it perform? Very well indeed! The RTX 3080 is way ahead of the outgoing RTX 2080 Ti. Bear in mind this card is actually replacing the RTX 2080 and 2080 Super in the product stack, and in that case it's an absolute belting. The performance per watt isn't massively improved but if you're going to drop \$1,500

on a GPU, you probably aren't worried about power consumption when you're getting such a huge gain in performance.

At 4K it's a good 25 percent faster than the previous flagship 2080 Ti, and well over 50 percent faster than its direct predecessor, the RTX 2080 Super. The difference isn't as big at lower resolutions, indicating that even a 5.1GHz all core 10900K is somewhat of a bottleneck, even at maximum settings! It's crazy really. The 3080 only really makes sense if you're gaming at maximum settings at 4K, you use an ultrawide, or use multiple screens (hello to all you sim racers!). Users with very high refresh rate monitors will love it too.

The MSI Gaming X Trio is damn fast. It offers good value too; at least, we hope so. We won't be surprised to see some price gouging going on in the shops once the initial batches sell out. Will the choice of Samsung as the foundry partner prevent shortages from happening? Time will tell.

Nvidia is off to a very strong start with the first of its RTX 30 series. The RTX 3080 sets a new bar, and the MSI flavour only raises it higher. And this is only the beginning. There's still the mighty RTX 3090 to come, and don't forget the very exciting RTX 3070 and 3060 models. These two in particular may really shake up the market if they are priced competitively. We're sure they'll sell like hotcakes anyway. The pressure is really on AMD now. RDNA2 cards will need to be something special if they are to compete with Nvidia in any relevant measure. The next great GPU battle has begun. Oh what a time to be a PC gamer.

The RTX 3080 redefines the high end GPU market with a stunning generational leap.

★★★★★

"Under full load, the cooler cannot be heard above the sounds of our AIO cooling fans or even the sound of the pump. Unless you have an airflow restricted case, we're confident in saying that this MSI won't be distracting you during your gaming sessions."

RTX 3080 BENCHMARK RESULTS

	Temperatures @		3DMark	
	Idle	Load	Time Spy Extreme	Fire Strike Extreme
MSI GeForce RTX 3080 Gaming X Trio	31	70	8,700	16,391
Nvidia GeForce RTX 2080 Ti	36	68	6,815	16,068
Nvidia GeForce RTX 2080 Super	38	72	5,524	13,285
Nvidia GeForce RTX 2070 Super	36	76	4,987	11,995
AMD Radeon RX 5700 XT	37	82	4,469	12,356

Indicates best result





\$TBC | lenovo.com

Lenovo Ideapad Slim 7

Lenovo's got something else inside... and we like it.

AMD's CPUs have spent the last few years shaking up the desktop space by giving Intel a run for its money, but we're now into the second generation of Ryzen CPUs for laptops and these chips are unequivocally thrashing anything Intel can put forward.

We recently crowned Asus's ROG Zephyrus G14 as the best ultrabook on account of its reasonable price and surprisingly high CPU performance. Lenovo's Ideapad Slim 7 isn't running the same chip as the G14, but it does have an AMD Ryzen 7 4800U CPU and 16GB of RAM on board, which wipes the floor with any 10th Generation Intel Core i7 CPUs we've benchmarked.

Most high performance i7 CPUs are hexa-core arrangements, so we're not too surprised the octa-core 1.8-4.2GHz Ryzen 7 4800U outpaces them, but even the Intel Core i7-10875H that we tested on the Razer Blade 15 (2020) was beaten by between 20 and 45

percent in raw multi-threaded CPU benchmarks. This won't translate perfectly into general PC computing performance, but it does mean that the Ideapad Slim 7 will outpace any ultrabook with a Core i7 that you can get your hands on.

Other than featuring a super processor the Ideapad Slim 7 looks like a pretty normal flagship Ultrabook. Up front is a vibrant 300nit 14-inch IPS display that runs at a 1080 pixel resolution and will hit 100 percent of the sRGB colour gamut. It even gets a Dolby Vision certification for HDR content and is paired with Dolby Audio virtual surround sound to make media playback as good as it can be on a laptop. The bezels are slim and while the laptop isn't a convertible or touchscreen the hinge does allow it to fold back to 180-degrees, which is an appreciated flexibility when in a tight spot on-the-go.

The Ideapad Slim 7 also has more connection offerings than you get

SPECS

Windows 10 Home
64-bit; 14-inch
300nit IPS display
(@ 1920x1080 pixel
resolution;
1.8-4.2GHz AMD
Ryzen 7 4800U CPU
(8C/16T); 16GB
RAM; AMD Radeon
Graphics; Intel
Wi-Fi 6 AX200;
60Wh battery
(8h50min 1080p
movie playback
lifespan); 320.6 x
208 x 14.9mm;
1.4kg.

on Lenovo's Yoga range (or most contemporary Ultrabooks for that matter) including a HDMI output, microSD card reader, two USB Type-A slots, two USB Type-C ports and a 3.5mm audio jack. The keyboard has a nice feel to it, even though it's about as shallow as keyboards get and the trackpad is smooth to touch and easy to use.

Under load you'll get around four hours out of the Ideapad Slim 7's battery and a decent eight hours and 50 minutes in 1080p movie playback.

Unfortunately the AMD Radeon Graphics aren't as impressive as the CPU, performing better in some benchmarks and worse in others against Intel Iris Plus Graphics (the most common integrated 10th Gen Intel i7 GPU). So you won't want to pick up any GPU heavy tasks, but, that said, there's still enough oomph here for light indie games or general photo editing.

Lenovo hasn't confirmed its plans to release this model in A&NZ at the time of writing, but its components are very similar to the Lenovo Yoga Slim 7 that is available from Harvey Norman for \$2,699 – so if you really want to get your hands on an AMD powered ultrabook then we'd recommend you divert your energies here.

JOEL BURGESS

One of the most powerful ultrabooks around with solid battery life and a nice screen make this unit a compelling offer.

★★★★★

Indicates best result

	Lenovo Ideapad Slim 7	Lenovo Yoga C940-14IIL
PCMark 8 - Home (score)	4,458	3,832
Cinebench R20 - multi-threaded CPU	1,515	674
PCMark 10 - Overall (score)	5,165	4,563
3DMark Fire Strike (score)	1,375	702
Battery life - 1080p video playback (h:min)	08:50	08:35
Peak CPU temperature (°C)	115	100
CrystalDiskMark Read (MB/s)	3,481	2,569.9
CrystalDiskMark Write (MB/s)	2,185	2,984.6



\$2,499 | consumer.huawei.com/en

Huawei MateBook 14

Huawei's back with another affordable ultrabook, but is it enough to stand out in the competitive flagship laptop space?

Huawei's MateBook 13 scored full marks when we looked at it last year, and with new 10th gen Intel CPUs, upgraded discrete graphics and a bigger battery, everything looks in place for this to be another impressive offering. The most obvious difference is the new 14-inch screen, which returns with the same 2160 by 1440 pixel resolution in a 3:2 aspect ratio that is good for viewing web pages. At 300nits it isn't the brightest screen available, but it's bright enough for general work tasks and media playback when cranked right up. The screen also has a decent 90% screen to body ratio with 4.9mm bezels on the top 3 edges after it followed the MateBook Pro X in dropping the webcam to a popup keyboard button.

The chassis looks and feels nice still, but even though the manufacturing has been updated to offer a smoother chassis finish, the overall design is starting to

look a little dated next to today's leading ultrabooks. Sadly there's no Wi-Fi 6, even though it's packing 10th gen CPUs and one of the 2 USB Type-A ports is USB 2.0 for some reason, which makes it less than ideal for transferring data with a max speed of 60MB/s. And while the new gesture controls and HDMI ports are welcome inclusions, we can't help but feel that more established vendors have either conquered these hurdles already, or moved to more advanced solutions.

The MateBook 14 is using an Intel Core i7-10510U CPU, a Nvidia GeForce MX350 GPU and 16GB of RAM, which makes it basically identical to the MateBook X Pro, except with a more powerful graphics card. This makes it a powerful work device that'll plough through most people's workloads and stand up to any of today's best ultrabooks. While this chip isn't any more powerful than

SPECS

Windows 10 Home
64-bit; 14-inch
IPS touchscreen
@ 2160x1440
pixel resolution;
Intel Core
i7-10510U CPU;
16GB RAM; Nvidia
GeForce MX350
GPU; 30.8x22.4x
1.59cm; 1.53kg.

what you got on the MateBook 13, raw CPU tests show up to 22% improvements in PCMark 10's overall work benchmark. Like it's predecessor, this GPU also gives it the ability for sub-1080p gaming. You can get playable 30fps frame rates on titles like *Total War Warhammer II* and *Middle Earth: Shadows of War* if you turn the settings to low, but you'll probably want to drop a little below 1080p resolution to ensure stability.

The thing we can see, other than the screen, that makes this device less expensive than the MateBook X Pro is the larger form factor. At 1.53kg and 1.59cm thick the MateBook 14 is just 9.5 percent and 13 percent bigger than its flagship sibling, respectively. Which isn't a big deal when you consider the price difference. Even the battery was almost identical at 56Wh, which lasts around nine hours in media playback and about three under intensive workloads. So there's not a heap of difference between this device and an \$800 more expensive MateBook X Pro.

That said, we're in the price bracket of a similarly specced Microsoft Surface Pro 7, Acer Swift 5, Lenovo Yoga 940-14IIL or an MSI Prestige 14 – all of which we'd grab ahead of the MateBook 14.

JOEL BURGESS

A powerful ultrabook with a little extra GPU headroom for light gaming and decent battery life.

★★★★☆

Indicates best result

	Huawei Matebook 14	Huawei Matebook 13
PCMark 8 - Home (score)	3,604	3,695
Cinebench R20 - multi-threaded CPU	708	718
HWBot x265 - 1080p (fps)	18.662	21.19
3DMark Fire Strike (score)	3,916	3,293
Battery life - 1080p video playback (h:min)	9h7min	4h37min
Peak CPU temperature (°C)	95	94
CrystalDiskMark Read (MB/s)	3,261	3,268.4
CrystalDiskMark Write (MB/s)	2,631	2,414



\$1,399 | www.netgear.com.au

Netgear Orbi Tri-band Mesh Wi-Fi 6 System

Netgear comes out swinging with a powerful device, but is it worth the enormous price?

For some months now we've been using Asus' Zen Wi-Fi products to power the internet around our home. The system essentially has two primary nodes that have a dedicated backhaul channel between them, reserved for a direct, high-performance connection between the two. This was so robust and fast that we were finally dissuaded from relying on a powerline connection to connect our main, gaming PC to the internet at the other end of the house. It's been peerless. Until now.

Netgear's Orbi Wi-Fi 6 Mesh system is a similar beast, but with nodes that are twice the size (25cm tall each!) Set-up is simple: download the app, scan a QR code and follow the prompts. The app offers some good insights into the network and correctly identified all connected devices even if they were running through other networking products. Anything can be easily paused at any time. There are also numerous advanced wireless network monitoring tools but channel scanning, optimisation and detection is all automatic so they're largely decorative.

A notable feature is called Netgear Armor which secures your network and informs you of events like new connections, failures or

threats blocked. It's powered by BitDefender but only a measly, one-month license is provided. After that you're supposed to pay a \$70 annual subscription which is reduced to \$41 for the first year. Most rival, premium, AX routers offer similar, Trend Micro-powered protection for free, indefinitely.

A system called Anywhere Access provides connectivity to your network and devices from across the internet. However, beyond these basic features, the app doesn't offer much else. Traditional advanced settings like port forwarding and VPN are available through a web browser, but there's no meaningful QoS capability and built-in parental controls resemble beyond ham-fisted blocking features. If you want proper parental controls you need to install another app: Norton Circle. The basic version of this allows for the usual device assignment and time limits but advanced features (which are often free with rivals) require another premium subscription which costs \$15 per month!

We had high hopes for its performance with 6Gbps bandwidth spread across one 2.4GHz and two 5GHz bands. We ran our usual tests in a three-storey

SPECS
Tri-band
AX6000Mbps; 4
Gigabit LAN, 1 x
2.5Gbps WAN;
WPA3 Security;
One month
Netgear Armor
Internet Security;
Amazon Alexa and
Google Assistant
compatible.

Sydney townhouse with the modem and primary node on the ground floor and the secondary node two floors up. We downloaded large video files from our Synology DS1019+ NAS to our Dell XPS 15 near each node and on the floor in between. Moving upwards through the house it managed 630, 372 and 364Mbps respectively which compares to Asus' 613, 450 and 445Mbps. Few people will notice any difference in performance but the Asus is slightly faster at distance.

So, it comes down to value. We initially balked at the Zen Wi-Fi AX's \$899 price tag, saying in our review that the \$550 Zen Wi-Fi AC (which offered similar but less robust speeds) offered better value. In the face of all this, the Netgear Orbi's staggering \$1,399 price (plus premium subscriptions!) is ridiculous. Ultimately, it's a good product but farcically overpriced in this market.

NICK ROSS

A powerful device with a lot to recommend, but let down by out of touch pricing and absurd subscription costs.

★★★★☆



\$300 | www.dlink.com.au

D-Link DIR-X1860 Wi-Fi 6 Router

D-Link fills a price-gap in the market, but is the product worth considering?

A few months ago we reviewed D-Link's first budget Wi-Fi 6 router, the EXO AX1500 Wi-Fi 6. We complemented it for being the cheapest Wi-Fi 6 router on the market and for offering blistering, close-range speeds (although performance dramatically declined at distance). Now, here's D-Link's EXO AX1800. It costs \$50 to \$100 more (depending on where you buy it) and has an RRP of \$299. So, what does the extra, nomenclatorial 300 get for the money?

Both devices resemble traditional, four-pronged Wi-Fi routers and use D-Link's standard Wi-Fi app. Setup requires scanning a QR code (in the box) which walks you through the connection. The 2.4GHz band and 5GHz band are combined into one network so you simply choose a network name and password (plus a device administrator password). If you use the app to log in to a D-Link cloud account you can set up Google Assistant and Amazon Alexa voice commands which enable you to pause internet, reboot the device and check login credentials.

The app is intuitive and allows you to do the following: see which clients are connected, enable

guest Wi-Fi, turn off the four, bright, status LEDs, update the firmware and set parental controls. The latter lets you set-up different profiles which enable different devices to access the internet, at different times, during the week, in 30-minute increments. As with the AX1500, there's no network security and so we wondered where the extra money was going.

We had our concerns: the AX1500 was so-called because it offered 300Mbps theoretical speeds across its 2.4GHz band and 1,200Mbps across its 5GHz band. The AX1800 boosts the 2.4GHz band by just 300Mbps to 600Mbps. That's a bit like saying the difference between two cars is that one can go faster than the other when they're both in first gear – modern Wi-Fi performance all comes from using 5GHz bands. This, plus the fact that Wi-Fi-rated performance is only theoretically possible in laboratory conditions, made us wonder if we'd see any difference at all.

We ran our standard tests which involve downloading large video files from a Synology DS1019+ NAS to a Dell XPS 15 laptop in a three storey Sydney townhouse in three locations (the

SPECS
Dual-band
AX1800Mbps; 4
Gigabit LAN, 1 x
Gigabit WAN;
parental controls,
QoS, Amazon
Alexa and Google
Assistant
compatibility.

router was on the ground floor): up close, one floor up and two floors up. The AX1800 managed a decent 582Mbps up close but repeatedly plummeted to a pitiful 8Mbps in the subsequent tests. We forced it to use the 5GHz band only and speeds increased to 582, 105 and 26Mbps as we moved up the house. Conversely, the AX1500 managed 735, 61 and 22.5Mbps... but without having to force the 5GHz band.

Comparisons between the two models are rendered moot by the existence of TP-Link's \$159 AX1500 router which scored 387.5, 191 and 157Mbps in the same tests. Despite being cheap-and-plasticity looking, its performance at distance is significantly better and it's almost half the price of the DIR-X1860. This leaves the DIR-X1860 looking expensive and underpowered even in this budget end of the Wi-Fi 6 market and so is not worth considering.
NICK ROSS

Despite being a budget router, it's expensive and underpowered.

★★★★☆



\$2,725 | business.panasonic.com.au

Panasonic Toughbook A3

Panasonic's most rugged Android tablet yet doesn't disappoint.

Field workers often find themselves in harsh environments where a standard consumer grade tablet just wouldn't be able to withstand the cold, heat, rain or other conditions they encounter, which is why they turn to rugged tablets such as Panasonic's new Toughbook A3. The company's latest rugged tablet is the successor to its Toughbook A2 that launched back in 2016 and a number of upgrades have been made to the device that make it an even better fit for those in working in industries such as the military, construction, government, law enforcement, healthcare and enterprise.

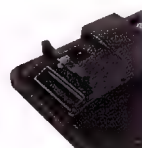
Although the device weighs 0.9kg it doesn't feel overly heavy. The tablet is a little bit more than half an inch thick at 1.65cm and the device feels very sturdy with no bending or give whatsoever. The 10.1-inch screen takes up most of the front of the device and is protected by a metallic bezel that wraps all the way around which also houses a 5MP front-facing camera, microphone and ambient light sensor. A hard plastic shell protects the edges of the Toughbook A3 from drops and here you'll find a total of eight physical buttons with five of these

being completely user customisable along with a volume up, volume down and power button.

If you flip the Toughbook A3 over, you'll find two hot swappable 3,200mAh batteries that are locked in place with two slidable tabs. Underneath each battery there is a nano SIM slot and the tablet can be outfitted with two SIM cards.

As a fully rugged device, the Toughbook A3 has an IP65 rating which means the device is water and dust resistant but not waterproof. It is also certified to the latest MIL-STD-810G standard and can withstand six-foot drops. Panasonic has even tumble tested the A3 by putting it through 500 tumbles from 3.3ft at a rate of five rpm.

The Toughbook A3 is powered by Qualcomm's SDM660 octa-core CPU clocked at 2.2GHz and by 4GB of LPDDR4 RAM. There is 64GB of eMMC storage built into the device but this can be boosted by up to 64 GB with a microSD card. Battery life is one of the A3's biggest strengths and the tablet lasts for up to nine hours with the two standard 3,200mAh batteries. However, Panasonic also offers dual extended life 5,580mAh



Qualcomm
SDM660
Octa-core
processor;
Android 9.0;
10.1in LCD 1920 x
1200 glove-
enabled touch
screen; IP65
water and dust
resistant; 9 hour
battery life.

batteries that allow the device to run for up to 15.5 hours on a single charge.

The Toughbook A3 ships with Android 9.0 and Panasonic's bundled apps which include a note taking app, a file copy utility, a whitelisting/blacklisting app, a hardware diagnostic app, a rapid configuration app for enterprise deployment and a barcode reader app.

The Toughbook A3 may only have 4GB of RAM and be powered by a Qualcomm chip from 2017 but during our time with the device it performed quite well and was able to boot up from a powered off state in just over twenty seconds. Apps opened quickly and there were never any crashes or hang ups during our testing. The A3 also received several security updates while in our possession.

ANTHONY SPADAFORA

The Panasonic Toughbook A3 is well-suited for tough jobs in less than ideal conditions thanks to its IP65 and MIL-STD-810G certifications, and can easily be customised to meet the needs of both field workers and first responders.

★★★★★



From \$189 | shop.westerndigital.com

WD My Passport SSD

USB 3.1 Gen2 device gets an NVMe refresh.

Western Digital's lineup of direct-attached storage (DAS) products targets a range of markets and form-factors. After the acquisition of HGST / G-Technology and SanDisk, the company now offers similar products under multiple brand names. Portable bus-powered SSDs are an example. Subtle differences in the feature sets of the products enhance their appeal to the brand's target market.

Late last year, the WD_Black P50 was introduced as the fastest non-Thunderbolt portable SSD in the market, thanks to its USB 3.2 Gen 2x2 interface. The branding clearly indicated that gamers were the target market. The regular WD branding is reserved for the My Passport series. The first model in the My Passport SSD series was back in 2017, and it used the planar TLC-based SanDisk X400 M.2 SATA SSD internally with a USB 3.1 Gen 2 Type-C host interface.

A new version of the My Passport SSD was released the following year with a WD Blue 3D NAND SATA SSD using 64L 3D TLC flash. Both products were held back performance-wise by the use of a SATA SSD. This product now brings NVMe into the picture for the My Passport SSD product line.

The WD My Passport SSD targets productivity use-cases for business professionals (including certain content creators). The new version's industrial design and appearance has changed, with the sharp corners and fully-plastic enclosure now replaced by an aesthetically-pleasing partial metal enclosure having rounded corners. WD claims that the new design feels less rigid and more portable, and has a more pocketable shape overall.

While the WD_Black P50 and the SanDisk Extreme Pro portable SSDs meant for huge games and large media files used

the WD Black SN750 NVMe SSD internally, the new WD My Passport uses the DRAM-less WD Blue SN550 NVMe SSD. This still uses a PCIe 3.0 x4 interface, and the performance numbers for the 500GB+ models are good enough to saturate a USB 3.1 Gen 2 interface. Hardware encryption is one of the key features of the higher-end products in the My Passport line-up, and the new My Passport SSD also supports AES-256 for data protection without performance loss.

The WD My Passport SSD 2020 provides a huge leap in performance (up to 1050 Mbps) compared to the 2018 version (540 Mbps). The 256GB capacity SKU has been phased out, and only three capacities are offered – 500GB (\$189), 1TB (\$319), and 2TB (\$629). While the My Passport SSD 2018 was available only in a single colour (grey/black), the 2020 version is available in four colours: grey, red, blue, and gold.

GANESH T S

"The new version's industrial design and appearance has changed, with the sharp corners and fully-plastic enclosure now replaced by an aesthetically-pleasing partial metal enclosure having rounded corners."

Western Digital has yet another compelling offering in the portable SSD market.

★★★★☆





Affordable alternate OS laptops

Laptops specialist **Joel Burgess** rounds up the best Chromebooks and Windows 10 S laptops to see how good lightweight PCs are for today's cloud-based workflows.

Cost is generally the driving force that motivates someone to consider a Chromebook, and while cost generally equates to compromise, Google's Chrome OS has developed into an elegant and versatile operating system that can be even more efficient than Windows 10 for certain workflows. In much the same way MacOS fits into Apple hardware so seamlessly, you get a similar feeling of continuity and ease of use from a Chromebook running ChromeOS. For those with an Android phone, or anyone that's used the GSuite web apps it won't be a surprise to hear that Google is on top of the game when it comes to simple to use cloud software design, and Chrome OS is perfectly suited to make the most of Google's online document processing tools.

Sure, more intensive or detailed workloads are going to require Microsoft's productivity expertise or Adobe's creative clout, but for small business, students and individuals, Google is the clear winner on cost and ease of access. All the online apps are free for any user with a Google account and Chromebooks come with a one year subscription to Google One, which bolsters your online storage from the free 20GB

base storage to 100GB, and allows you to share this space with five family members (a privilege that usually costs \$25 a year).

Google Sheets and Docs have all the essentials for producing basic spreadsheets and simple written documents, and while it isn't as feature rich as Microsoft's alternatives, this streamlined system is faster online and easier for newcomers to master. Both of these attributes combine with a responsive web browser and standalone apps to make Google's documents the easiest of the bunch to collaborate with others on – a feature that is becoming more and more important by the day.

The Chromebook's excellent work solutions are complemented by Android's large catalogue of lightweight apps that are almost all available on Chrome OS and run well on laptops and 2-in-1s.

Even the cheaper Chromebooks are capable of running the full gamut of smartphone designed software, and while you will have a less full-featured experience in many applications, the software translates well and often makes it easier to just get on and do what you need to do.

Windows 10 S

If you want a budget device, but you're really keen to keep your PC-styled OS, then Microsoft will tell you that Windows 10 (in S Mode) is a good solution for today's low powered PCs. Much like the name suggests however, Windows 10 (in S Mode) isn't so much a carefully curated operating system for low powered PCs as it is a mode that restricts you from a world of applications that your computer may not be powerful enough to run well.

We've never been able to see any battery benefits from running laptops in S Mode, and performance doesn't seem to be affected whatsoever these days, so we really don't see much point in ever using S Mode... even on the most lightweight PCs like Kogan's 11.6-inch Atlas here.

Fortunately, swapping from Windows 10 (in S Mode) to full Windows 10 Home or Pro is as simple as toggling a switch in your settings... you don't even need to restart the device to continue using it (which may give some indication as to why you don't really see any performance benefits from S Mode).



\$1,799 | asus.com/au

Asus Chromebook Flip C436F

A souped-up Chromebook with a premium price tag.

While it might not be the most powerful Chromebook here, the Chromebook Flip C436FA from Asus is still probably more powerful than you'd expect. The unit we tested had an Intel Core i5-10210U CPU, 8GB of RAM and a 256GB M.2 PCIe SSD, but the device generally sold locally has a smaller 128GB SSD. At \$1,799 this device is hardly a bargain... in fact, seeing as you can get a similarly specced Microsoft Surface Laptop 3 or a 13-inch Apple MacBook Air for less, Chrome OS seems to come at a premium here.

We had mixed feelings around the overall design. The lightweight metal chassis feels a little cheap considering the price, and the included stylus had a poorly designed magnetic clasp, but the keyboard, trackpad, Harmon Kardon speakers and hinge design were all sophisticated and nice to use. The 14-inch FullHD IPS display was decent for a Chromebook offering

compact 4.9mm edge bezels and an 85 percent screen to body ratio.

Performance was more than what you'll likely need on Chrome OS, but the overhead does give you the freedom to not worry about how many tabs or desktops you have open. We were a little disappointed by the 42Wh battery life which lasts just two hours and 34 minutes under graphical load and six hours and six minutes for 1080p movie playback.

As good as the Chrome OS is, it's not the same as running full Windows 10, and this PC is more than powerful enough to run a proper desktop OS. Considering the price and the limited experience the Chromebook Flip C436FA is a tough pill to swallow.

A powerful Chromebook that is overpriced and doesn't bring anything novel.
★★★★☆

\$1,945 | dell.com/en-au

Dell Latitude 7410 Chromebook Enterprise 2-in-1

An enterprising Chromebook that's worth considering for a workforce.

If you think all Chromebooks are budget PC alternatives then the Latitude 7410 Chromebook Enterprise 2 in 1 will come as a bit of a shock. This business-focused laptop has the same Intel Core i5-10310U CPU and 16GB RAM as you'll see in today's premium ultrabooks and the device can be upgraded further to include a 10th Gen Core i7 chip. Up front, most configurations offer a FullHD 14in 300nit display, but it does range to a 400nit 4K screen. Whether it's the sleek metal chassis, the skinny edge bezels, the polished convertible hinges or the pinhole HD webcam everything else is pretty much what you'd expect from a flagship ultrabook.

The Latitude 7410 is also perhaps one of the more easily connected devices offering a HDMI out, Dual USB Type-C connections, a microSD card reader, two USB Type-A sockets, a 3.5mm

headphone jack and a lock attachment. The keyboard is nice and the trackpad is smooth and responsive.

Unsurprisingly this device had some of the best benchmark scores. Battery life isn't bad either, lasting three hours and eight minutes in GFX Bench and nine hours and 36 minutes in 1080p movie playback.

So the only thing really holding this device back is the price. In the US an extra \$90 will give you Google's Chrome Enterprise management upgrade, which makes it easier to deploy imaged systems with enhanced business security that can be remotely updated. So it might save your company money in the long run.

A pricier Chromebook that makes some sense for small businesses looking to roll out lots of laptops
★★★★☆

"Unsurprisingly this device had some of the best benchmark scores across the board, so it'll be more than powerful enough to run the most demanding Chrome OS software."



\$599 | lenovo.com

Lenovo Ideapad Duet Chromebook

Lenovo's latest Chromebook is showing Windows 10S what it should look like.

We were pretty blown away by Lenovo's Ideapad Duet Chromebook. If you put it next to a Microsoft Surface Go 2, you'd notice that the Chromebook's keyboard was fractionally harder to type on, the back panel stand made it a little heavier and they run different operating systems, but that's not a lot when the Surface Go 2 starts at \$629 (or \$829 with keyboard) and the Ideapad Duet Chromebook comes with keypad and stand case for \$599.

While we definitely prefer the hardware from Microsoft, Chrome OS is a much richer operating system than Windows 10S to use with a lightweight 2-in-1, especially if you already use Gmail or any of the other G Suite apps. That said, the 10.1-inch 1920 x 1200 pixel display looks vibrant and offers a 400nit peak brightness and other than the overly small right hand side keys the keyboard is easy enough to type on and comes

with a nicely sized, smooth-to-touch trackpad.

If you're a tab hoarder, you'll probably hit the upper limits of the device's MediaTek P60T eight-core processor and the 4GB of RAM pretty quickly, but anyone who's happy to keep things to just a handful of tabs shouldn't really have any issues. Battery life was good too, lasting five hours and 31 minutes in gaming benchmarks and seven hours and 45 minutes in 1080p movie playback.

There are a couple of minor setbacks like the single USB Type-C port and a slow ~100MB/s flash memory at 128GB without the option for microSD card expansion, but at least Google offers 100GB of online storage to new users, which alleviates some of the pain here.

A great device that makes work easy for anyone on a tight budget
★★★★★

"If you're a tab hoarder, you'll probably hit the upper limits of the device's MediaTek P60T eight-core processor and the 4GB of RAM pretty quickly."

"The 11.6-inch touchscreen offers FullHD resolution and is bright enough to be easy to work on."



\$329 | kogan.com

Kogan Atlas 11.6in C500 Convertible Laptop

Is this unbelievably cheap Windows 10 offering too good to be true?

The Kogan Atlas 11.6in 2-in-1 was by far the most affordable laptop of the roundup, so you have to be willing to give it a few concessions on this basis alone. The most noticeable of them is that while it isn't the most compact keyboard of the roundup, it does feel like it thanks to an awkwardly small spacebar that sits too far to the left. There's also an obvious flex in the soft plastic chassis and sharp edges that'll press on your hands, particularly on the left since the keyboard skews that way. The hinges have an unnaturally tough feel to them and the power cable is a thin pinhole connection with a large base that looks more like something that powers an electric shaver.

The 11.6-inch touchscreen offers FullHD resolution and is bright enough to be easy to work on, although the viewing

angle isn't great and you do get a lot of glare from the glossy screen finish.

Rather than shipping with Windows 10 S as seen on some of its siblings, the Atlas 11.6in C500 Convertible Laptop actually comes with a full Windows 10 Pro OS, which is pretty amazing when you consider that this OS retails for an RRP of \$339 – i.e. more than the cost of this laptop.

The Atlas C500 had faster flash memory than the Lenovo Ideapad Duet Chromebook at over 200MB/s for both read and write speeds and while the 27Wh battery life isn't exactly great, it's enough to get half a day's work done before you need to charge.

An exceptionally good value device for those that can handle a handful of minor concessions.
★★★★★

"While this model only offers Wi-Fi networking and doesn't carry a heap of storage space, the Surface Go 2 does feature a MicroSD card expansion slot, to allow you to add cost effective storage as you see fit. "



\$879 | microsoft.com

Microsoft Surface Go 2

Is Microsoft's second attempt at a price conscious ultra-portable 2-in-1 a Go-er?

The most affordable Surface Go 2 you can grab locally starts at \$598, and comes with an Intel Pentium 4425Y processor, 4GB of RAM and 64GB of onboard storage, which is an offering that seriously competes with some of the best Chromebooks available. While this model doesn't carry a heap of storage space, the Surface Go 2 does feature a MicroSD card slot.

The next tier up doubles the RAM and storage allocations for a total of \$879. This clearly moves the device out of the budget Chromebook space when you add the \$199 Surface Keyboard, but we'd recommend considering it if you intend to update to Windows 10 Home from the stock Windows 10 S OS.

The Surface Go 2 has a bigger 10.5-inch 1920 x 1280 (3:2) PixelSense display that is really vibrant for a budget screen, even though it only manages a peak brightness of 280nits. In Geekbench 4

performance was around 35 percent lower than we saw on a Samsung Galaxy Book S using a Snapdragon 8cx processor, which makes sense when you consider the 8cx is intended to be the mobile architecture equivalent of a 10th-gen Intel Core i5.

It's hard to imagine a use case for this device without the need for the Surface Go Signature Type Cover, so you'll have to plan for that extra \$199.95 outlay, but the typing experience is good and the trackpad is silky and generously sized.

The 26.8Wh battery lasts five hours and five minutes in PCMark 8 Home battery and around eight hours in 1080p media playback.

A powerful, affordable and lightweight computing device that's perfect for students and professionals that only need light document processing and web browsing. ★★★★★



\$1,699 | samsung.com/au

Samsung Galaxy Book S

A lightweight, long-lasting laptop that'll keep you constantly connected.

Samsung is a master in the phone space and when you consider that top end phablets are almost as powerful as entry level laptops, it makes a lot of sense for Samsung to be dipping its toe into the 2-in-1 space. The main benefit of using a mobile processor like the Qualcomm Snapdragon 8cx is that it's light on power consumption drawing just 7W, which means it doesn't need any fans for active cooling. This is how Samsung can claim 'multi-day battery life' with the 42Wh battery apparently holding enough juice to offer 25 hours of movie playback.

Despite the efficient design Qualcomm claims performance that approaches 15W Intel U series chips... being chips that require an active thermal array. We struggled to benchmark this unit fully since it was running Windows 10 S (which limits

applications to what you can get on the Microsoft Store, curbing our usual test suite), but based on Geekbench 4 results it basically lines up with the performance of the first Microsoft Surface Laptop from 2016 ... or the least powerful laptop chips currently available.

If you only plan to use your device for web browsing then the long battery life and option for constant 4G sim-card connectivity might be appealing enough to pay the \$1,699 RRP. For this you get a 13.3-inch FullHD screen, 8GB of RAM, and 256GB SSD (with microSD expansion) in a package that's less than 1.2cm thick and weighs under a kilogram.

A long lasting premium ultrabook that offers exceptional portability and constant LTE connectivity. ★★★★★

"The main benefit of using a mobile processor like the Qualcomm Snapdragon 8cx is that it's light on power consumption."

Conclusion

Considering the price points of the entry level devices here, it's impressive what they are able to achieve.

Kogan's Atlas 11.6in C500 might not have the nicest exterior or interface, but the device performed as well as anyone could hope for, being only around 27% behind Lenovo's Ideapad Duet Chromebook in Geekbench 5. This means that it was capable of running any of the browser-based tasks we threw at it without any major stalls or noticeable lag. Of course 4GB of RAM isn't going to stretch too far if you do happen to download more demanding applications and fire them up on the unrestricted Windows OS, but as long as you're aware that the device isn't going to be able to do it all, you'd be surprised by how much it can actually achieve.

What is perhaps the most poignant take home message of this roundup is that Chromebooks are an excellent alternative to Windows 10 for lightweight systems. In much the same way as Apple's iPad OS takes the app landscape of iOS and tailors it into a rich PC-like experience for devices like the iPad Pro, Chrome OS does a similar job for

Chromebooks... especially the more affordable units. Google is uniquely positioned to offer great low powered PC alternatives and we're genuinely surprised that Chromebooks aren't a bigger feature in the local market. If we were contemplating going for Microsoft's entry level Surface Go 2, but wouldn't mind something even less expensive, there are a suite of Chromebooks that will offer a more streamlined experience than anything offered by something running Windows 10.

If you are looking for something a little more powerful, then there's a couple of avenues you can go down. Windows 10 is light enough these days for it to run really well on something like Samsung's Galaxy Book S, and if you are sure you don't need extra overhead for demanding processes like photo

editing then it makes sense to use a more efficient mobile processor that's constantly connected via LTE. You can achieve a similar scenario with the LTE Surface Go

2 models without feeling like you're trading down on hardware, but it's interesting to see that Chrome OS is a decent alternative to Windows 10 for more moderately powered ultrabooks too. And while we're not sure the price is in the sweet spot just yet, Chromebooks have managed to design an Enterprise Management system that makes it much easier for small businesses to set up and maintain a fleet of laptops. Which is a great alternative for

anyone hoping to save a little on the IT costs of maintaining and keeping secure a workforce of Windows 10 devices.

"Windows 10 is light enough these days for it to run really well on something like Samsung's Galaxy Book S, and if you are sure you don't need extra overhead for demanding processes like photo editing then it makes sense to use a more efficient mobile processor that's constantly connected via LTE."



AFFORDABLE ALTERNATE OS LAPTOPS SPECIFICATIONS

	Asus Chromebook Flip C436F	Dell Latitude 7410 Chromebook	Kogan Atlas 11.6-inch C500 (W10S)	Lenovo Ideapad Duet Chromebook	Microsoft Surface Go 2	Samsung Galaxy Book S
Score	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆
Street price	\$1,799	~\$1,945	\$329	\$599	\$879	\$1,699
CPU	Intel Core i5-10210U	Intel Core i5-10310U CPU	Intel Celeron N3350	MediaTek P60T	Intel Pentium Gold 4425Y	Qualcomm Snap-dragon 8cx
Memory	8GB	16GB	4GB	4GB	8GB	8GB
GPU	Intel UHD Graphics	Intel UHD Graphics	Intel UHD Graphics 600	Mali-G72	Intel UHD Graphics 615	Qualcomm Adreno 680 Extreme
Storage	256GB	256GB m.2 SSD	64GB Flash storage	128GB eMMC	128GB	256GB SSD
OS	Android 9	Android 9	Windows 10 Home S	Android 9	Windows 10 Home S	Windows 10 Home S
Touchscreen	Yes	Yes	Yes	Yes	Yes	Yes
Screen size	14-inch	14-inch	11.6-inch	10.1-inch	10.5-inch	13.3-inch
Resolution	1920 x 1080	1920 x 1080	1920 x 1080	1920 x 1200 (240ppi)	1920x1280	1920x1280
Wi-Fi type	Wi-Fi 6	Wi-Fi 6	AC	AC 2x2 MIMO dual band	Intel Wi-Fi 6 AX200	AC or LTE
Battery type & capacity	42Wh	52Wh	27Wh	91Wh	26.8Wh	42Wh
Weight	1.1kg	1.63kg	1.1kg	920g (450g tablet only)	544+245g	0.96kg
Dimensions (mm)	319.5 x 205.3 x 13.7	321x211x18	277.5x189x18.8	245 x 169 x 18.2	245x175x12.7	305.2 x 203.2 x 11.8
Thickness (cm)	1.4cm	1.8cm	1.9cm	1.8cm (0.7cm tablet only)	1.3cm (0.83cm tablet)	1.2cm

AFFORDABLE ALTERNATE OS LAPTOPS BENCHMARK RESULTS

Indicates best result	Asus Chromebook Flip C436F	Dell Latitude 7410 Chromebook	Kogan Atlas 11.6-inch C500 (W10S)	Lenovo Ideapad Duet Chromebook	Microsoft Surface Go 2	Samsung Galaxy Book S
Geekbench 5 Single Core (score)	852	1,042	421	262	473	700
Geekbench 5 Multi-Core (score)	2,854	2,841	734	932	983	2,760
3D Mark Sling Shot	4,224	4,511	DNT	1,381	DNT	DNT
GFX Bench 1080p T-Rex Offscreen (score)	3,630	3,646	1,668	2,083	DNT	DNT
GFX Bench 1080p T-Rex Offscreen (fps)	59	59		37	DNT	DNT
GFX Bench 1080p Manhattan Offscreen (Score)	6,436	6,060	878	1,260	DNT	DNT
GFX Bench 1080p T-Rex Offscreen (fps)	115	108		20	DNT	DNT
GFX Bench Battery Manhattan 3.1 Battery Lifespan (min)	154	188	DNT	331	DNT	366
Androbench Read sequential MB/s	691	587	263	98	1,784	1,046
Androbench write sequential MB/s	773	584	208	132	847	421
Battery life - 1080p video playback (h:min)	06:06	09:36	03:30	07:45	08:00	11:39

SOFTWARE

APPS FOR ALL YOUR PLATFORMS



WINDOWS

Premiere Pro | \$45.99 per month | www.adobe.com DaVinci Resolve | \$FREE or \$475 | www.blackmagicdesign.com

Premiere Pro vs DaVinci Resolve

Choose your champion in the battle of the big video-editing apps.

Two great titans enter the arena. Only one will leave triumphant. These kinds of multi-camera, effects-laden scenes are precisely what Adobe's Premiere Pro and Blackmagic Design's DaVinci Resolve were designed to cope with, and it also neatly describes the battle between pro-level non-linear video editing apps. There must be a word for that.

There's room in this arena for both contenders, however. Nobody has to get hurt. In the red corner we find Premiere Pro, the shinobi from Adobe, famous for work such as *Deadpool*, *Terminator: Dark Fate*, and *Sharknado 2: The Second One*. Meanwhile, in the blue corner sits Australia's finest, DaVinci Resolve, fresh from working on *Deadpool 2*, *The Last Jedi*, and 35 films at the 2019 Sundance Film Festival you've never heard of.

This month we're comparing non-linear video editors. This is a type of editing in which the original footage isn't altered in any way. Edits are kept in the form of companion files generated by

specialised software, and on playback the edited video is recreated from a combination of these files and the original source files. This means that the finished movie must be exported as a new file in order to share it or play it back on a different device. It sounds complex, but it's the way most video-editing apps work. You'll need a fast PC, a high-resolution monitor, and a large amount of fast storage to work effectively this way.

The big news about DaVinci Resolve, which is owned by mind-blowingly expensive camera company Blackmagic Design, is that there's a free version that contains 90 percent of the Studio version. All that's missing is support for resolutions above 4K and frame rates above 60fps, support for multi-GPU systems, some advanced machine learning, HDR, and stereoscopic video tools. Were you thinking of making an 8K 120fps 3D HDR movie? Then you'll need to part with \$475.

For most people, the free version will suffice. It acts as a lure to

Adobe Premier Pro is the industry standard, and is quick to pick up.

interest potential customers in Blackmagic's keyboard with dedicated edit keys and a jog wheel, or the Advanced Panel that looks like part of the space shuttle. Video editing is a heck of a drug.

Resolve began life as a colour-correction tool, but has since expanded into almost every corner of video production. Much like Serif's Affinity suite, it's broken up into "pages" that offer different functionality. A big new addition is the Cut page, which acts as a lighter version of the main edit suite, and is designed for quick cutting on location, likely on a portable PC with a small screen. It's more streamlined than the Edit page, which assumes you're using a larger screen and therefore provides more tools, but it's enough to hack together something in five minutes to show a client while your camera operator is packing up their gear.

Other pages in Resolve include Fusion, which deals with video effects and 3D compositing; and Fairlight, which is a complete digital audio workstation (DAW)



with mixer, EQ, as well as dynamics processing, sound library support, and a lot more. Colour correction is still there too, with the Colour page dedicated to this subtle art. And finally, the Deliver page handles rendering and exporting, featuring presets for popular video-hosting sites, as well as having manual controls.

Industry standard

Premiere Pro, on the other hand, is available through Adobe's Creative Cloud subscription scheme that we discussed last month. There's no free version, but a cut-down video-editing program is available for a fixed price in the form of Premiere Elements. This is a different app, however, which shares little more than its name with Premiere Pro, and shouldn't be confused with the main event. Premiere Rush also exists as part of Creative Cloud, bundled with Premiere Pro (with which its projects are compatible) or as its own subscription – this app is aimed at quick mobile-editing of videos exported straight to YouTube or similar sites, like Resolve's Cut page.

Premiere Pro itself has many features designed to speed up the process of video editing, although how useful they are depends entirely on the project you're working on and the style of editing you prefer. Premiere Pro's

Da Vinci Resolve can more than hold its own against Adobe's best.

Assembly window lets you quickly splice clips together before taking them to the Edit window for fine-tuning, and there's colour grading, effects integration, and audio editing just as you'd expect. Premiere is an app to take your time with, its Lumetri colour-correction module operating more like Lightroom than Resolve's does. And while Blackmagic's app is an all-in-one solution, Adobe requires a separate subscription to After Effects if you want to add 3D or other motion graphics to your videos.

Adobe's products are the industry standard, and can be easier to grasp for beginners. Once you know the layout of one, you can find tools and palettes in many others, and this familiarity is a huge bonus for Premiere Pro. Many editors will want Photoshop installed on the same PC they use for video work, and the shared design language between the two apps goes a long way.

Resolve can more than hold its own against Premiere Pro, but sometimes using the standard app pays dividends for many professionals. Premiere Pro is on version 14, while Resolve is on version 16. These are mature applications that have been improved time and time again through feedback from industry professionals. The cost can be a large factor for those learning an

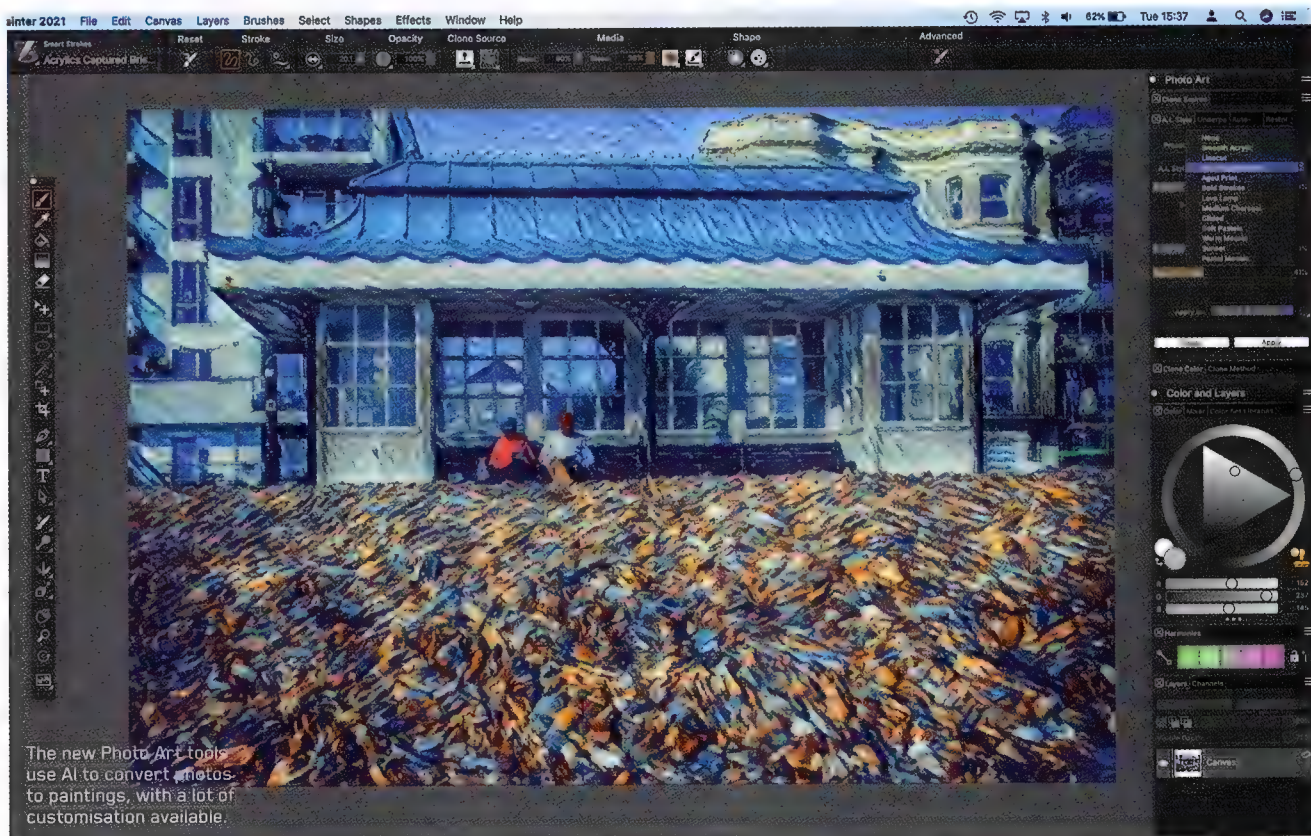
application or working on personal projects, so Resolve's free version scores highly. A year's subscription to Premiere Pro costs twice what Resolve Studio costs as a one-off payment, and this, along with the Fusion and Fairlight pages, makes Resolve a very attractive proposition.

If you're just dabbling in video editing, Resolve is a no-brainer, as it's free. If you want to learn, Premiere Pro does have a learning mode, but consider Premiere Elements, which takes you through the process of non-linear editing in an approachable way and gives you transferable skills you can use in other apps. Both Premiere Pro and Resolve Studio are serious toys, and while it would be wrong not to recommend an app for that reason, there's so much pro functionality available for so little money elsewhere, we wonder why any home user would want them.

IAN EVENDEN

Premiere Pro
Industry standard; easy to grasp; learning resources. Subscription pricing is a downer.
★★★★★

DaVinci Resolve
All-in-one; free version is amazing; dedicated hardware available. Enormously complex.
★★★★★



macOS 10.14 or later | \$614 | painterartist.com/en/product/painter

Painter 2021

AI and a wealth of creative tools help you to make digital art that's as good as the real thing.

Corel's graphics applications were among the first to ever become available to users with personal computers. Several decades on, Painter 2021 represents the latest evolution of what it is possible to achieve in digital art without ever going near a real paintbrush.

A powerful package with a dizzying array of tools and options, Painter rewards skill, like any professional creative software, but is also accessible for less

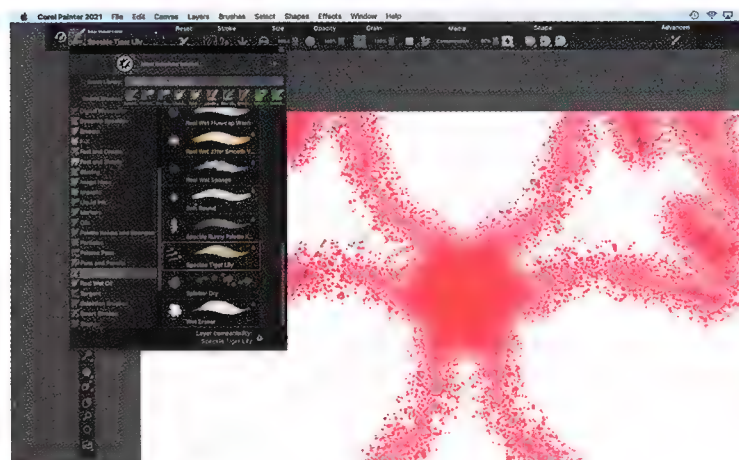
experienced users to experiment and learn to create. At its heart is a configurable canvas into which you draw content using a massive selection of over 900 brushes, each with its own settings and, if required, a number of types of layers. These layers – watercolour, liquid or thick paint, have their own tools and properties and can be used together to create art that might be near impossible when using real materials.



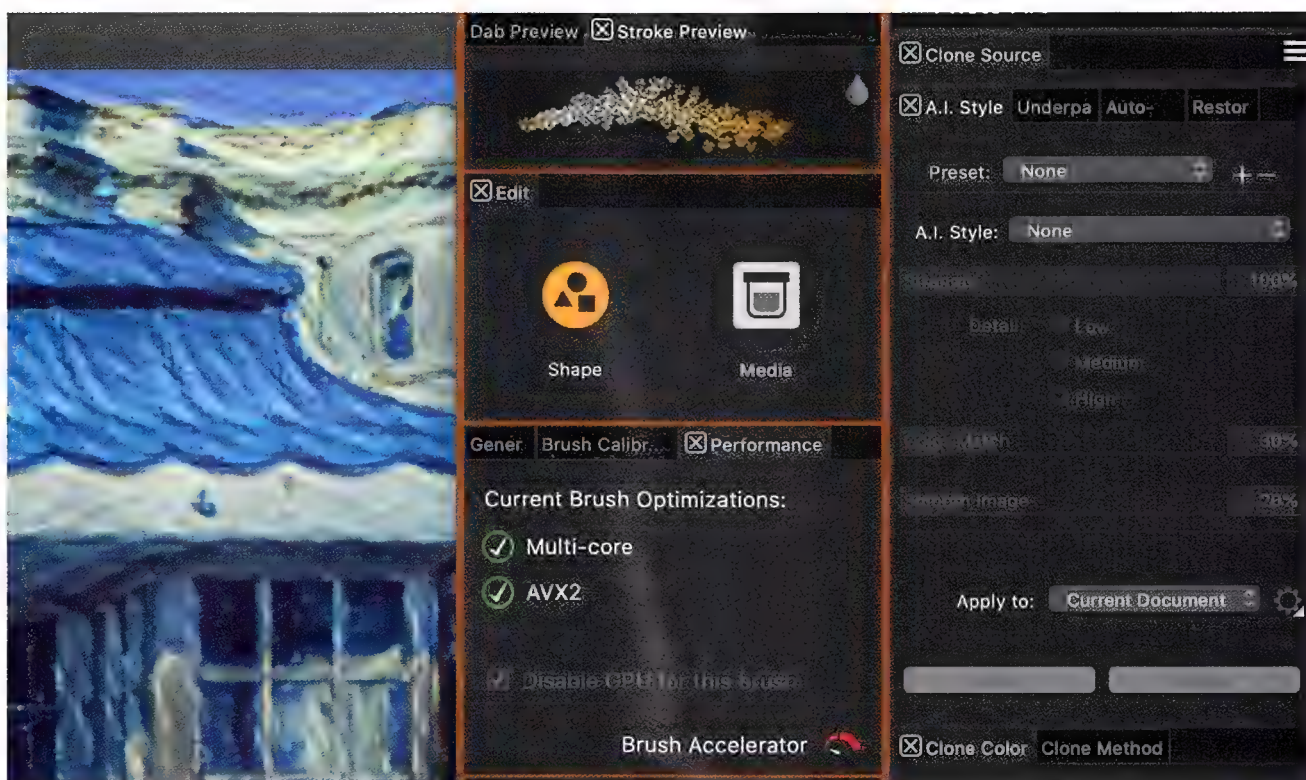
Brush bounty

The selection of brushes is vast and covers practically any eventuality. Particularly impressive are the new thick paint brushes, which simulate the application of various sizes and weights of knife and brush with uncanny accuracy. Strokes are thick and goopy, and painting over existing strokes with other colours causes the paint to blend and swirl as it would in real life. All this can be precisely controlled of course, with bleed, opacity, wetness and many other parameters able to be set easily. As with other brushes, right-clicking lets you quickly choose a new brush type, and the colour/layer palette floats helpfully to one side, even suggesting complementary colours as you go.

Photoshop-style tools are also available including cloning, magic wand, extensive selection tools, gradients, paint buckets and more. Powerful guide options can help you compose an image, and there are special modes including mirror and kaleidoscope painting



Use and customise over 900 brushes as well as special drawing modes like kaleidoscope and mirror. You can also use layers to blend paint types.



which duplicate brush strokes, making it easy to create complex patterns with minimal effort.

Mac support has been expanded in this latest version and as well as the usual graphics tablet support, you now get support for Sidecar. With painter's screen mirrored to an iPad, you can use an Apple Pencil to draw on the tablet's screen and this also now includes tilt support for brushing. There's also now Touch Bar support for compatible MacBook Pros, displaying context-sensitive controls as you change tools. In use, this is actually a great help to workflow. Finally, enhanced

trackpad support brings more multitouch gestures to the Mac.

Convert and control

Corel has added artificial intelligence support to Painter and here it's utilised for 'photo painting' – converting photographs (or indeed other kinds of images) to artworks. Call up the relevant control panel and you can select from 12 AI styles (landscape, portrait, and so on) and then a selection of styles (impressionist, abstract and more) to have Painter analyse and convert the image.

Naturally, there are a whole

bunch of controls to go along with this that determine strokes, detail and all manner of parameters and every time you change one, your Mac has to recalculate the new image but this isn't too arduous. You'll probably want to do some fine-tuning of the settings to suit your picture but overall it works very well and can provide some excellent conversions. One other new feature is clone tinting, which enables you to clone areas of a canvas but using custom colours. So you can use shape and texture but apply a new colour to the cloned areas.

Painter 2021 is a comprehensive and powerful painting suite that takes advantage of the latest Mac hardware and OS. It has an incredible selection of brushes and the Thick Paint workflow is remarkable. There is a learning curve but it is less steep than you initially expect, and it's quite possible for less experienced users to get a lot out of it. That said, Painter really comes into its own when used by a skilled artist. The gallery material online shows just what can be done by those who know their craft.

HOLLIN JONES

Top: Advanced control of brush behaviour is available and a Brush Accelerator can use your GPU to speed up painting responsiveness.

Above: The new Thick Paint tools recreate the look, feel and behaviour of thick liquid paint with uncanny realism.

An excellent digital painting application with features for everyone from beginners to pros. ★★★★★



\$16.99 | needs iOS 8 or later | iliumsoft.com

eWallet – Password Manager

Manage your passwords and card data.

For many people, the free iCloud Keychain feature built into iOS is good enough to manage website passwords and credit card data. Those with more advanced needs turn to more robust solutions like 1Password (subscription required) or LastPass (free tier, or subscription for Premium). Those of us in search of a capable, less expensive alternative need look no further than eWallet.

This universal app works similarly to other mobile password managers, storing a variety of sensitive personal data either locally or on your choice of cloud service – iCloud or Dropbox – for syncing to other devices. (For a one-time fee of \$16.99, your eWallet purchase covers both iPhone and iPad.) There's support for multiple wallets and unlimited entries, with the latest version adding Dark Mode.

Credit where it's due

The interface is friendly and easy to use, although it feels somewhat dated, with bright, colourful icons and a penchant for skeuomorphism. That's not entirely bad – older users will appreciate the simplicity of eWallet's approach, where identification, bank, credit, and other cards resemble their physical equivalents in the real world

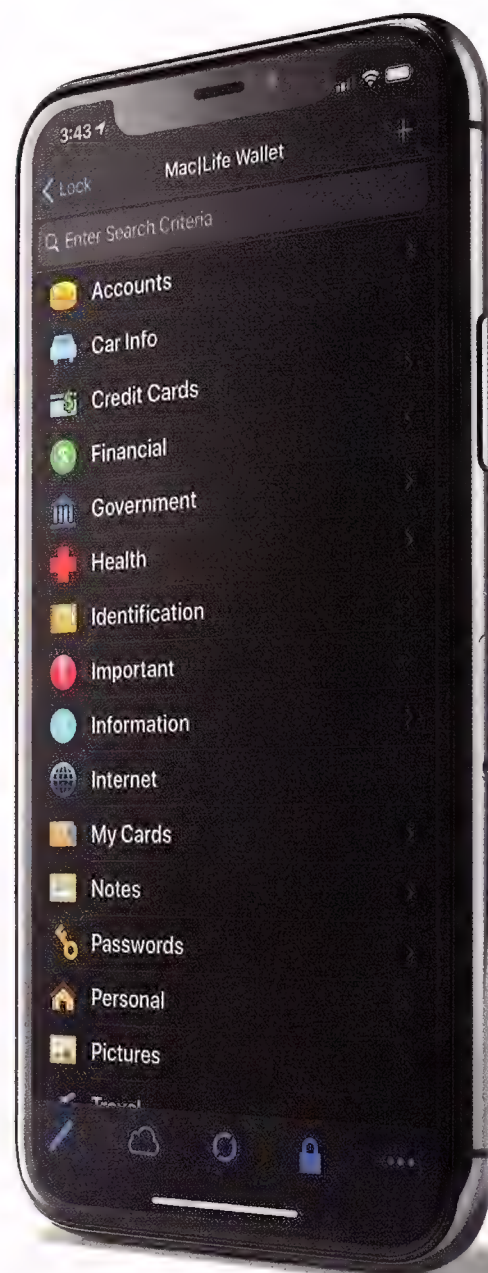
While the eWallet app checks off must-have security requirements like 256-bit AES encryption and the ability to generate passwords for new entries, there are a few omissions. For example, you can't use QuickType Autofill to unlock a wallet, so logging in to eWallet without Face ID or Touch ID biometric security is harder than it should be. Two-step verification also has yet to make its way into the app.

On the plus side, eWallet supports a wide range of categories, including preconfigured wallets for Health, Travel, Work, and Information. Unlike 1Password, which often treats organisation as an afterthought, eWallet entries must be added directly to a specific category, while remaining globally searchable.

We were impressed with how seamless automatic logins were using the built-in web browser. Simply open a Password entry, tap on the card, and the browser pops into the foreground with the relevant data filled in. eWallet includes a Pictures category for securely storing images, but photos must be cropped into a square card format.

Assuming you need to only manage passwords on iPhone

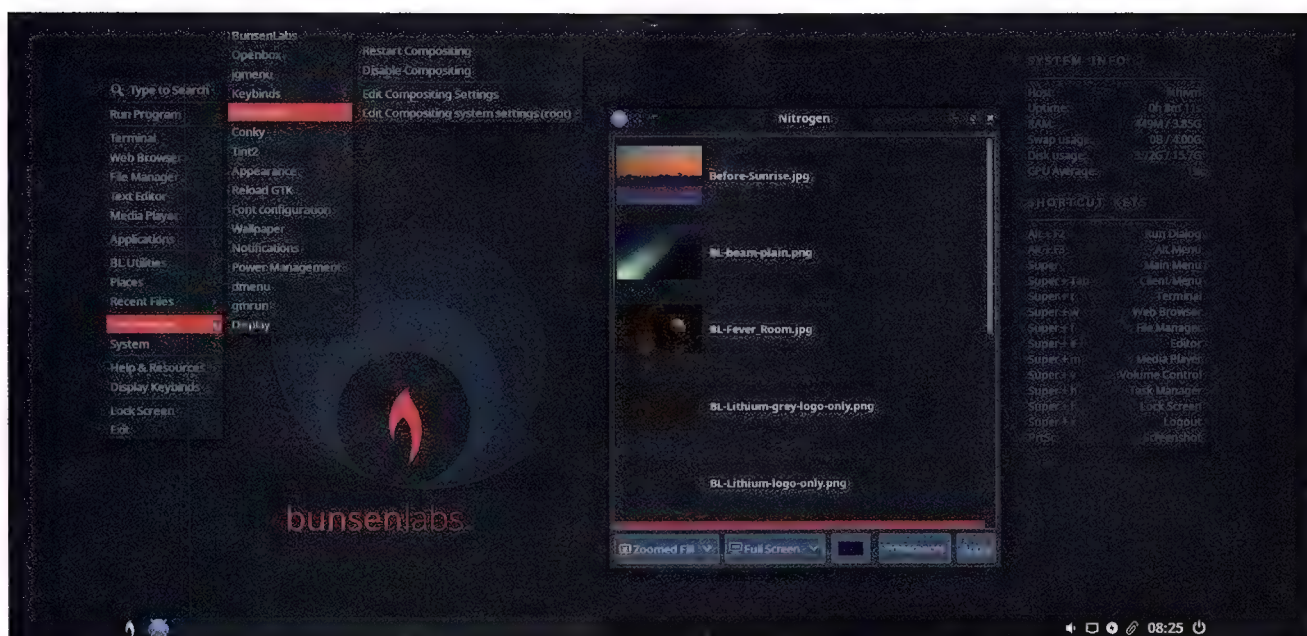
"Older users will appreciate the simplicity of eWallet's approach, where identification, bank, credit, and other cards resemble their physical equivalents in the real world."



eWallet features a wide variety of built-in categories to store your sensitive data.

and iPad, eWallet is a good deal. Once you factor in another cost to purchase the macOS or Windows apps, however, competitors like 1Password start to look more enticing. One annual fee provides access to apps on every platform, more polished software, browser extension support, and a proprietary cloud sync component that enables you to manage your data from any web browser. JR BOOKWALTER

The app's a bit old-fashioned, but it's a capable, affordable mobile password manager.
★★★★☆



Linux | www.bunsenlabs.org

BunsenLabs Lithium

Forever grunge Jonni Bidwell is pleased to find a distribution that's almost as good as the Nirvana song. Almost...

Sooner or later you become fed up of seemingly bloated desktop environments and turn to something lighter, be it OpenBox or i3. These are great – a gift in fact – but the learning curve is steep and a considerable amount of configuration may be required to get them into a state that meets your needs and desires. Even then, there's the temptation to delve into further rabbit holes, be they compositing and transparency effects, or setting up a custom applications menu. And let's not even talk about setting up Conky perfectly. Now imagine if a distro came with all of these set up out of the box...

Well good news, BunsenLabs does. And the new release is named after everyone's favourite rare earth metal. It's based on Debian Stable, so users searching for the latest versions of everything may want to look elsewhere. But for everyone else there's a lot to like here. New in this release is the adoption of jgmenu, as opposed to Openbox's native menu. The new system is configurable and works with Openbox pipe menus too, so if you've already created the perfect menu system there, then it should be easy to migrate.

Booting into a fresh install, you'll be prompted to run an optional post-

install script. This first warns you of the perils of adding Ubuntu PPAs or badly backported Debian packages, then updates your system. Next, it gives you the option of enabling the official Debian backports repo or Bunsenlabs own backports – again, warning you to be careful of these packages. Then it offers to set up Bluetooth, Java, Flash and Dropbox. It can optionally install Bunsen's meta packages for such things as Version Control Systems, web development and building Debian packages.

With that script out of the way you can admire the full extent of BunsenLab's style. The moody, dark theme is consistent across the desktop, Tint2 panel and Thunar file manager. If you browse in here you might notice the custom Papirus icon set, too. With the initial install coming in at under 3.5GB, there's not much in the default install, but we were pleased to see the Geany text editor (which is almost an IDE) and you have Firefox and LibreOffice, which covers a good chunk of most people's computing needs.

Where BunsenLabs excels is through showing you where all the desktop guts are configured, and offering easy menu shortcuts to do so. No more must you wrestle to open another terminal to restart



Bunsenlabs: keeping Conky configurations and cascading menus cool since CrunchBang Linux's unfortunate demise in 2015.

Conky. While the list of keyboard shortcuts in the latter is helpful to get started, sooner or later you'll want to replace all that with Conky wizardry and widgetry. If you do need help, there's a friendly community on the forums to assist you. And a whole subforum dedicated to using Conky to give you weather and lunar phase information on your desktop, should you need it. There's no official documentation besides the release notes and Getting Started sections in the forums, but the excellent Debian docs should at least point you in the right direction if you get stuck.

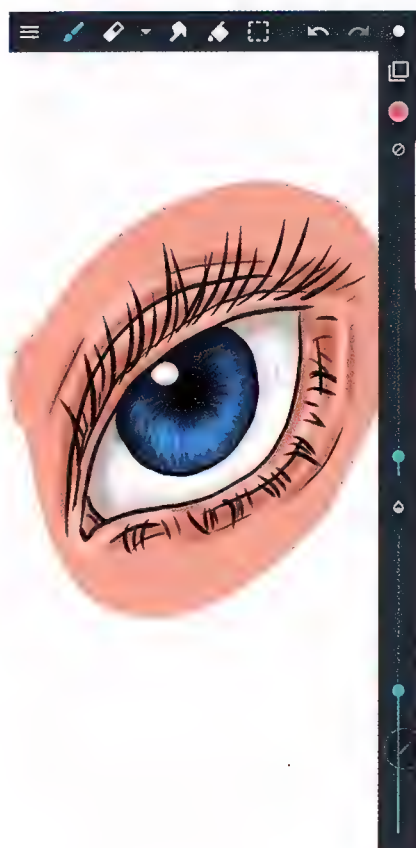
As you may suspect, the Openbox/jgmenu desktop is snappy and responsive. The applications (besides LibreOffice and Firefox) are lightweight, but still easy to use. Xfce's aforementioned Thunar is the default file manager and NetworkManager manages connectivity, so you won't need to get your hands dirty doing that. VLC will cover your media playing requirements.

BunsenLabs is one of an ever-decreasing number of distros to offer a 32-bit version (like Debian 10 it's supported until 2024), so if you're looking for something new for your old machinery, this is very probably what you seek.

JONNI BIDWELL

A flexible, stable, well-put together distribution that's well worth spending some time with.

★★★★★



Android

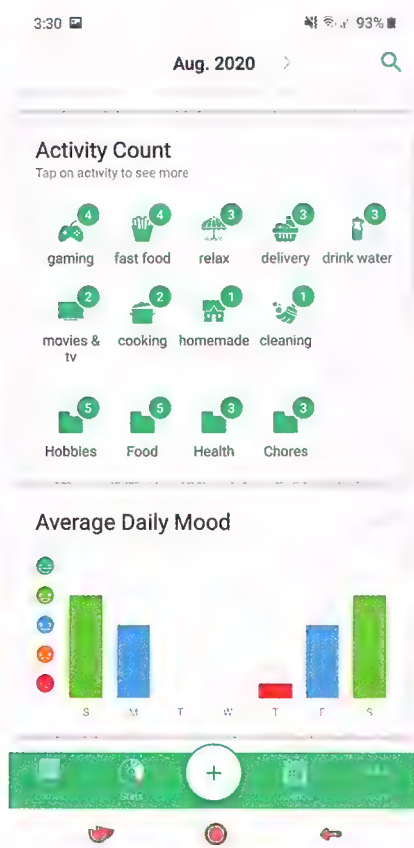
Art Flow

Art made simple.

Free/Play Pass/ In app purchases \$2.99 - \$8.49

The first thing I did when looking into what's included in Google's just launched in Australia Play Pass was find an app I'd genuinely be interested in trying. I looked at the drawing section and quickly found Art Flow, one of the higher rated apps in the bunch. This app is free, generally speaking, but Play Pass gets you all of the paywalled content, which is actually well worth it. For artists it means having access to all the tools, such as the ability to create your own brushes, which is exactly the kind of thing I'd expect in a pro drawing utility. It supports multiple layers, transparencies, colour pallets, and has lots of nice little extra bits in there. Plus you can even time lapse record what you're drawing to make cute little videos to show off. Art Flow proved its worth nice and quickly, and I enjoyed even initial experimentations, which is a really good sign in a drawing app.

★★★★☆



Android

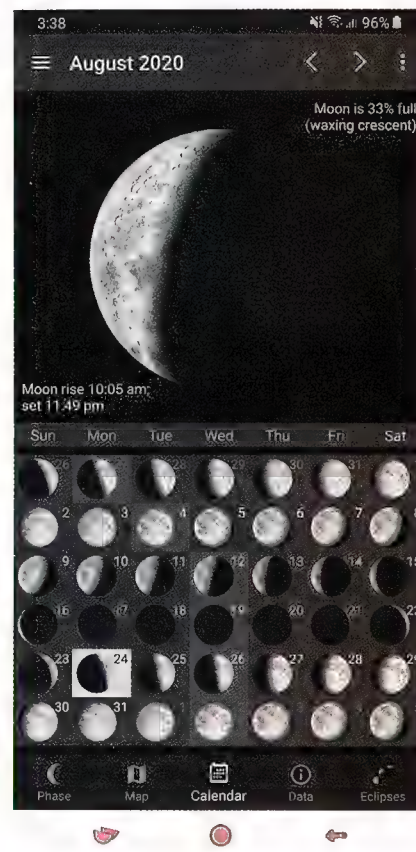
Daylio

Sad Mondays.

Free/Play Pass/ In app purchases \$1.49 - \$54.99 per item

There are a lot of different lifestyle apps included in Play Pass but I decided to try out Daylio. This focuses more on your moods and what activities coincide with them. It's quick and easy to put in the basic information for a day by ticking relevant activities. This means it's a small task, which is paramount to convincing me to do anything, every day. Daylio is good at making you wonder what makes you happy in your day-to-day and drawing the lines that join your days to your moods. You can use this information to set goals that might keep you happier in the long-run or just to do more things important to you. It can be especially helpful if you're introducing something new to your life, like medication or hobbies, and seeing how they affect your day. I like that Play Pass gave me the opportunity to test out all its functions, especially given how expensive some of the paid options are.

★★★★☆



Android

Lunescope Moon Viewer

Shoot for the moon.

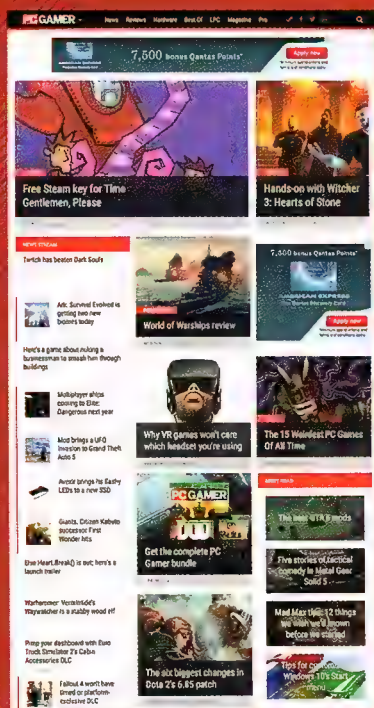
\$6.49/Play Pass

Lunescope Moon Viewer was another app I grabbed just because it looked different to everything else on offer. To some people the phases of the moon might have spiritual significance but I'm more moon-curious than anything else. I wasn't too sure why I'd want to know them, but Lunescope sure makes sure I can know every damn thing about them. This app is thorough. I can get a full calendar of moons, check out past and future lunar events like eclipses, or check out the full 3D map of the moons' surface. I can even zip to the various Apollo landings. This app appears to satisfy all moon desires both spiritual and scientific, with a definite lean towards the science side and I really appreciate that. It's the kind of app where almost anyone will probably learn something by having it, regardless of why they downloaded it in the first place.

HOPE CORRIGAN

★★★★☆

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Four. Eight. Six.



It was the first mainstream CPU to hit the one-million transistor mark and marked a huge turning point in PC performance at the time. So, in *APC's* issue #486, **Darren Yates** looks at an iconic Intel processor, its history and how it changed the PC.

Today's PC CPU market is a well-oiled manufacturing and marketing machine, with new iterations appearing yearly, almost like clockwork. In fact, any slide in launch date is guaranteed to make news. Yet, wind the clock back to 1989 and the four-year wait for new PC tech was finally over, as Intel launched one of its most important processors. It's the first mainstream CPU to crack the one-million transistor mark, the first chip to feature an on-board floating-point unit (FPU) and will go on to become joint-first x86 CPU to break the 100MHz barrier. It will also be embroiled in one of the most fiercely contested technology patent/antitrust

battles in history. It is the Intel 80486 processor.

The need for speed

By the late-1980s, the future of IBM's 'personal computer' concept was assured. Its rapidly-growing combination of software and 'IBM-compatible' clone machines had dealt a hammer-blow to the 8-bit home computer market. Intel's 80386 CPU of 1985 had also been a roaring success – not least for nascent PC brand Compaq. Having launched the PC in 1981, IBM would always be the PC's spiritual home. However, Compaq's release of the Deskpro 386, the first 80386 computer, in 1986 signalled a seismic shift in who had actual control of the PC

The Intel 80486 packed in over one million transistors, a first for a mainstream CPU.

market. The 80386 chip delivered to the PC its first taste of 32-bit processing that would power the industry for more than 20 years. But despite its success, it was still a long way from the processor architecture we'd recognise today.

The 80386 produced a 50% jump in Millions of Instructions Per Second (MIPS)/MHz performance over the 80286 CPU (0.33 vs 0.21). However, with no on-board floating-point unit (FPU), no on-board cache RAM and growing demand for more performance, the 386's 275,000 transistors had little left to give.

The arrival of the 80486 in April 1989 provided only a minor nudge in advancing the 80386 instruction set, but it packed a



sizeable wallop for speed. The launch chip ran at a comparatively sedate 25MHz, yet blitzed the higher-clocked 33MHz 80386 CPU in performance tests. By delivering the first on-board L1 cache RAM (a modest 8KB), plus the first integrated FPU, the 80486 more than doubled the average MIPS/MHz performance of the 80386, peaking at 1MIPS/MHz for the first time. The fastest 80386 then available, the 386DX-33, delivered just under 10MIPS of performance. Those who could afford the 25MHz 80486 (the 486 cost nearly three times the 386 at time of launch) could tap into an average 20MIPS, peaking at 25MIPS.

The 80486 had a number of other architecture tricks up its sleeve also, including faster burst-mode memory loading that filled up 16 bytes of cache inside five clock cycles, three cycles faster than its predecessor. Like the 80386, its 32-bit addressing enabled the 80486 to handle 4GB of RAM, but with RAM prices as they were, most systems were lucky to see 16MB of RAM. Nevertheless, the 80486 would give many users their first taste of the future, through Microsoft's new Windows 3.1, as well as 3D gaming, via new titles such as Wolfenstein 3D. Many would also eventually be upgraded to Windows 95.

Share and share alike

IBM's decision to design a new 'personal computer' using only off-the-shelf components from multiple suppliers – and then allow key partners, Intel and Microsoft, to on-sell their

components to other brands – brought the phrase 'IBM-compatible' to every computer buyer's lexicon. As long as a computer was 'IBM-compatible', it had ready-access to a fast-growing wealth of software. Software incompatibility was the scourge of the '80s home computer user and 'IBM-compatible' revolutionised the market.

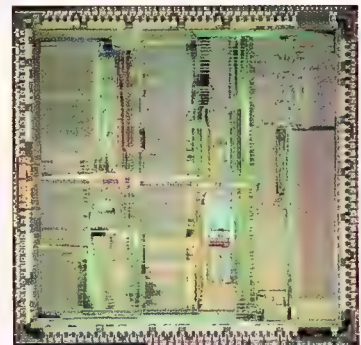
The original 1981 IBM 5150 PC was an instant hit from the start and 'Big Blue' couldn't make them fast enough. However, with its huge success, supply chain worries were never far from mind for IBM and in awarding Intel the contract to supply CPUs, IBM also required Intel to bring in a second source to supply chips in the event that Intel couldn't keep up. Intel chose AMD, the deal giving AMD access to the Intel 8086/88 and new 80286 processor technology. However, it was a partnership that would eventually sour into one of the fiercest technology legal battles in history.

IBM was Intel's major customer in those early years and IBM owned the PC market. But while IBM-compatibility killed off the 8-bit home computer market, it also loosened IBM's grip on the



Above: The IBM 5150 'Personal Computer', the PC epoch-zero.

Right: The die of the Cyrix 486DLC processor.



PC market as competitors, such as Compaq, began to successfully muscle in, especially following Intel's launch of the 80386 in 1985. Compaq's Deskpro 386 launched the following year was a watershed moment in this new IBM-compatible world, as consumers began to realise the CPU inside the box mattered more than the brand on the outside of the box. What's more, having sole effective control of CPU development, Intel found itself with a winning hand – and was ready to play it.

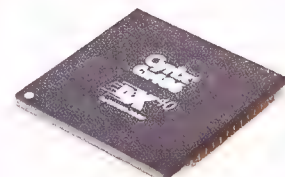
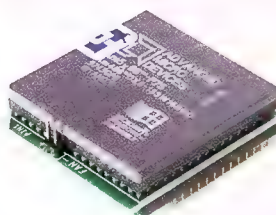
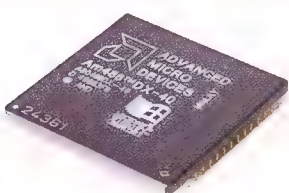
Don't mention the war

With IBM's grip on the market loosening and Intel's tightening, Intel chose not to share with AMD details of its new 80386 jewel.

Far left: AMD's Am 486 delivered equivalent performance to the Intel original.

Left: The AMD Am5x86-133 delivered Pentium-75 performance to 486 systems.

Right: The Cyrix 486 was that company's first main processor release.

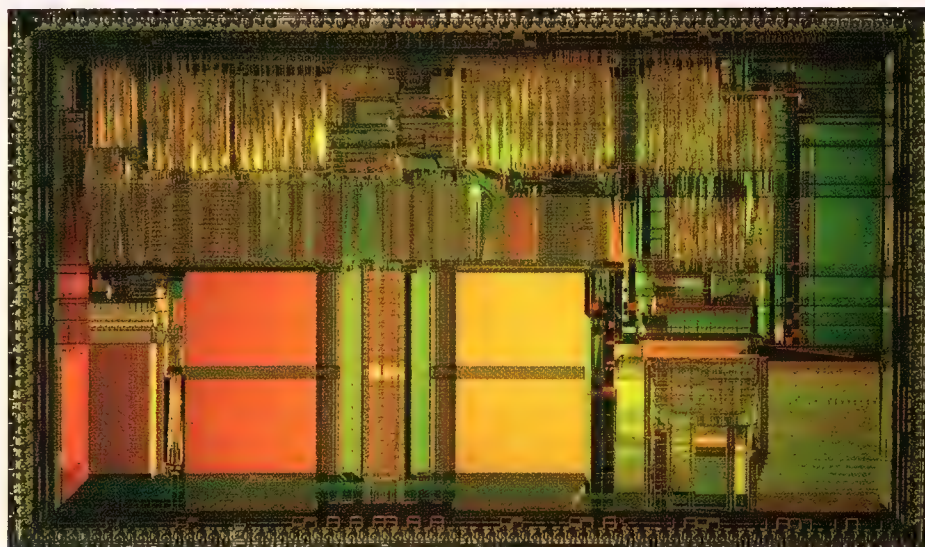


AMD claimed this contravened their existing technology-sharing arrangement and sought legal arbitration in 1987. Astonishingly, both companies would continue to square off in the courts for much of the next 22 years before Intel paid AMD \$US1.25 billion as part of a final settlement, ending the war in November 2009. Forget 'Apple v Samsung' – 'Intel v AMD' remains the gold standard for longevity of tech legal battles. What makes it all the more surprising is that the founders of Intel and AMD had all at one time worked at pioneering chip company, Fairchild Semiconductor – Gordon Moore and Robert Noyce left Fairchild and founded Intel in 1968, while Jerry Sanders left and started AMD the following year.

Intel Inside

The 80486 design was also responsible for innovations that are part of the PC fabric today. Aside from its integrated FPU and L1 cache, the first significant performance update arrived in March 1992 with the release of the 486DX2 series. This marked the first time a CPU core clock speed was decoupled from the front-side system bus and clocked at a higher multiple. Thanks to this double-clock multiplier, 486DX2-40 and -50 chips could drop in place of the original (now-designated '486DX') 5-volt parts and deliver more speed. The hugely popular 486DX2-66 arrived in August that year.

Despite launching the new fifth-generation Pentium CPU in 1993, Intel continued to release new 486 parts with the DX4-series in early 1994. The new



The die of the Intel 486DX2-66 processor.

triple-clock-rate DX4-100 doubled the L1 cache RAM to 16KB, with clock speeds reaching 100MHz for the first time alongside the new Pentium-100. The 80486 was also the initial focus of the famous 'Intel Inside' market campaign launched in 1991.

Attack of the clones

The decision not to share its 80386 tech with AMD gave Intel a free swing at the booming PC market. However, AMD believed its previous tech-sharing agreement covered the 80386, as a derivative of the 80286. So, AMD reverse-engineered its own 'Am386' chip. The process reportedly took 18 months but with further legal woes, the first chips weren't shipped until 1991. Still, they were a success, with the 40MHz part faster than Intel's best 33MHz version, while lower in power consumption and price.

AMD's first-generation Am486

was also a clone of the Intel design, with the launch 'Am486DX' chips appearing in April 1993 as 25, 33 and 40MHz models. Second-gen 'DX2' units appeared at 50, 66 and 80MHz the following year and topped 120MHz for the third-gen 'DX4' in 1995.

However, the path to market for AMD's 486 efforts was also anything but smooth. AMD's original 1987 arbitration claim blew out into an eight-year legal war between the two chipmakers. While AMD won the case brought by Intel over the Am386, the 80486 battle dragged on before the two antagonists settled in early 1995, with AMD gaining access to Intel 80486 microcode. This reportedly led to two versions of AMD's 486 – one cloned from Intel microcode, another using AMD microcode via a 'cleanroom design' process. Importantly for Intel, the settlement confirmed the 80486 would be the last Intel CPU cloned by AMD.

Left: The Compaq Deskpro 386 bat IBM as the first 80386 PC to market.

Below: Intel pioneers Andrew Grove (left), Robert Noyce and Gordon Moore in 1978 (Image: Intel).



Enter Cyrix

In a parallel universe, the Intel 486 also caught the eye of recently-minted Cyrix Corporation, which had to this point specialised in co-processor chips for 80286/386 systems. Cyrix was a fab-less chipmaker, relying on SGS-Thomson (now ST Microelectronics), Texas Instruments and IBM to make its chips. The first Cyrix 486SLC/DLC versions of the 80486 appeared in 1992 loaded into an 80386 package. With PCs far more expensive than today, a ready market existed for users

wanting to keep their current system and just upgrade the processor. The Cyrix 486xLC chips, however, with only 1KB of L1 cache and no FPU, couldn't match the genuine Intel 486 versions. However, Cyrix released Cx486DX and DX2 versions in 1993 that were closer to Intel-equivalents. Nevertheless, Intel and Cyrix sued each other, with claims of antitrust behaviour against the former and patent infringement by the latter. By January 1994, existing license deals between Intel and chipmakers Texas Instruments and SGS-Thomson delivered a court victory for Cyrix, which also dropped the antitrust claim.

Meanwhile, the arrival of the Intel Pentium in 1993 with its new CPU socket left increasing numbers of 486 users looking for alternatives. Buoyed by its 1994 legal win, Cyrix became a specialist at the CPU upgrade market, releasing its '5x86' in 1995, with versions clocking at up to 120MHz as a drop-in replacement for 486 systems operating at a 3.3V voltage. The Cyrix 5x86 was a stripped-down power-efficient Pentium-alternative based on its own 'M1' core that would go on to power its popular '6x86' chips the following year. The 5x86 delivered performance levels up to a Pentium-75.

After settling its case with Intel in 1995, AMD also had success at the upgrade market, launching the 'Am5x86' in November that year. Essentially a 133MHz souped-up 80486, it offered twice the L1 cache and a built-in X4 multiplier to work on original DX boards. Memory brand Kingston Technology launched its short-lived 'TurboChip' CPU upgrade range with a 133MHz Am5x86 for 486 systems.

Not surprisingly, Intel saw the trade AMD and Cyrix were doing in upgrades and pulled out its big gun, launching the Pentium OverDrive in 1995. This was a

modified Intel Pentium core with a 2.5x-clock multiplier inside an 80486 package, capable of running on boards with a 25 or 33MHz front-side bus at either 5V or 3.3V. Unfortunately, with a top speed of only 83MHz, these OverDrive chips struggled on both speed and price.

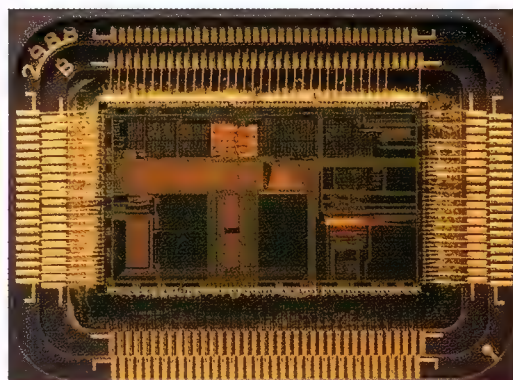
How much?

By today's standards, PCs in the early-90s weren't cheap. A 486DX2-66 desktop with VGA monitor, 4MB of RAM, 320MB hard drive and dual-speed CD-ROM from brands likes Olivetti or Compaq sold for around \$3,500. That said, one of the first PCs I reviewed was a Pentium-133/Windows 95 desktop PC in late-1995 selling for a cool \$7,800.

However, one of IBM's most important decisions from a consumer perspective in developing the 'personal computer' concept was to allow Microsoft and Intel to on-sell their tech to other brands. It meant anyone with sufficient knowledge and intestinal fortitude could set themselves up as a PC maker – and many started out this way as one or two-man shows, including iconic brands Gateway and Dell. Buying from these smaller builders could save you up to 40%, dropping the price of a \$3,000 big-name-brand 486DX2/66 system to as little as \$1,800 and often with more features.

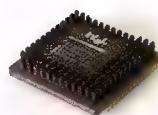
The 486 today

So, after more than 30 years, how does the 80486 stack up against today's wonder-chips? There's no doubt the 486's 1MIPS/MHz performance is pretty modest, particularly up against AMD's current Ryzen Threadripper 3990X with its 64 cores and claimed 500MIPS per core. Nevertheless, you'll still find a computer on the market today with 486-equivalent performance.



Above: The Intel 486 processor with cover removed, showing the bond wires.

Below: Intel created its own 'Overdrive' CPU upgrade for older 486 systems.



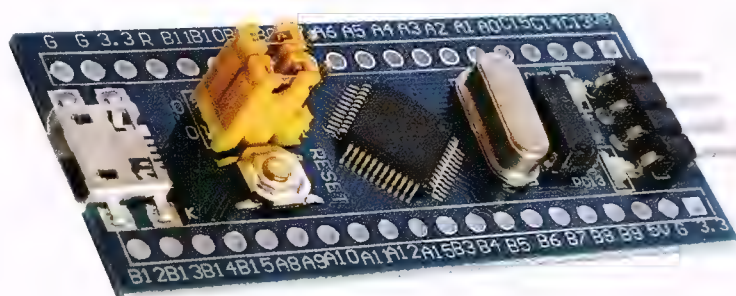
Say hello to the STM32F103C8T6, a 32-bit Cortex-M3 microcontroller designed by smartphone CPU company ARM and manufactured by ST Microelectronics. It clocks in at 72MHz with a 1.25MIPS/MHz performance rating and I use it in my home-brew Arduino projects. It's available on Ebay today for just \$5. Download the Arduino IDE software (www.arduino.cc) and you can code it using the C++ programming language.

Legacy

With over 70 different versions from Intel, AMD and Cyrix (not including those from IBM, SGS-Thomson, Texas Instruments and others), the 80486 will give the original 8086 a run for its money as the most iterated x86 CPU in history. Yet despite the drop-in clones and upgrades, the 80486 was nearing the end of its run when the Windows 95 revolution arrived, ensuring Intel rode the wave of success aboard its latter Pentium processors as Microsoft's new operating system changed the way we viewed computers.

Yet, as the Pentium CPU took hold, Intel still found a ready market for its 386/486 cores in industrial applications, only stopping production on both in late 2007 and paving the road for today's booming embedded processor market.

Nevertheless, despite the CPU families that have passed since, the 80486's legacy – its bus multiplier, on-board cache and FPU – lives on today. So as we mark issue #486, we also pay tribute to one of the most iconic CPUs of the last 50 years. Nice work, 80486.



This STM32F103 CPU on this \$5 board is slightly faster than an 80486.



ARMing THE WORLD

Apple is dumping Intel processors for its own ARM-based designs. Will the traditional PC be next?

No one would have believed in the last years of the 20th century that the processor world was being watched keenly and closely by intelligences greater than Intel's. Yet in the UK, intellectuals vast and cool regarded the processor market with envious eyes, slowly and surely drawing their plans against Intel...

Apple is dumping Intel processors for its own design of silicon. How did this happen, and what, if any, are the ramifications to the wider PC market? How can a processor design that started life in an obscure, failed British

home computer of the 1980s now challenge the entire Intel empire? We're going to delve into the ARM microarchitecture, have a look at how it's advanced over the years, how those architectural advances have borne out in benchmarks, and contrast the results to those of Intel desktop parts.

As we do this we're going to find two contrasting stories: One of maximising performance increases generation by generation, and the other offering fixed incremental increases from generation to

generation. We can delve behind the reasoning for why those increases played out like they did, and we can argue if ultimately those have been good decisions or not.

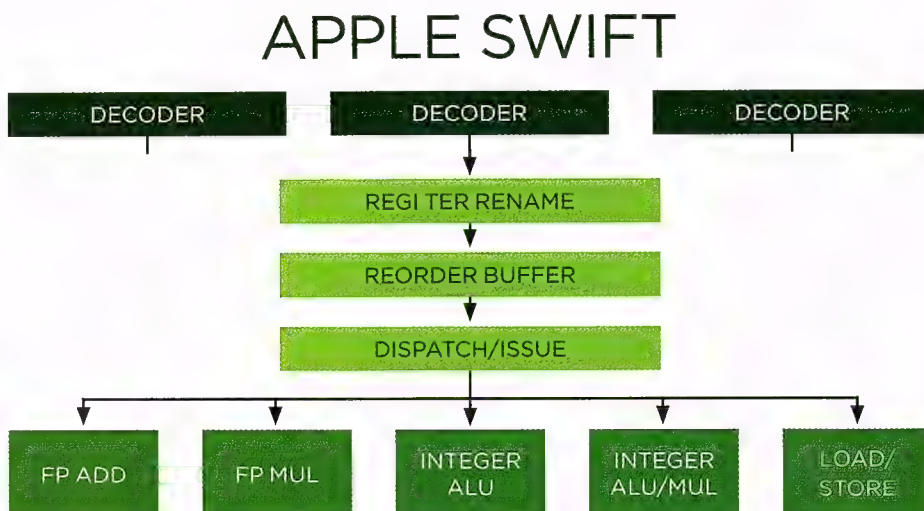
We can also argue about competition in the marketplace and ultimately how that's good for us, the consumer. But an architecture running an entirely different instruction set – is that good for PC consumers? Perhaps we're getting ahead of ourselves.

NEIL MOHR

What is an Intel processor? What is a PC? When IBM was part-picking, it could have gone with its own IBM 801 RISC processor, but the budget insisted on the Intel 8088, and history was set: Every compatible PC would be running an x86-compatible processor.

Technically anyone “could” design and manufacture an x86-compatible processor, but legally Intel owns the patents to the instruction set and has to license it for that to happen. If a company has ever produced a design or manufactured an x86 processor, it’s because Intel (or a court) allowed it to. AMD is different, as it has a complete cross-patent licensing agreement with Intel, so the two companies don’t end up suing each other into oblivion.

Over the years there has been a choice of different x86 manufacturers: IBM made a range of 386/486 processors, AMD, Cyrix, VIA, NEC, Transmeta, and some others, with the running theme usually being low-end designs. Intel has always been the



x86 top dog, with the others (apart from AMD and the IBM days) being also-rans. So you could argue there has been competition in the market, if fighting over the dregs counts as competition.

The point is that there’s almost no competition for Intel in the market – even today with AMD doing well it commands just 18

The 2012 Apple-designed Swift core was a huge step forward.

percent (Mercury data) of the consumer market. AMD itself said it was aiming for 10 percent of the server market in 2020 and aiming to claw back to the heights of the Opteron days during 2006 of a heady 25 percent market share.

It’s fine to lament the lack of competition, but what can possibly change to break the status quo? The big recent announcement is that Apple will start to move away from Intel-based processors and switch all of its hardware to its own design of processor. Apple’s not talking about just laptops or low-end iMacs, but even its high-end workstation offerings that use the Intel Xeon. It’s a bold statement, but how is it going to manage?

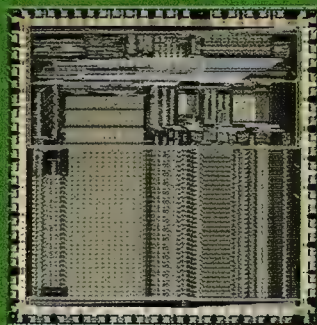
They seem Armless

Back in the 1980s CISC seemed fine, but a plucky UK company called Acorn Computers Ltd wanted a processor to take on the IBM PC, Amiga, Atari ST, and Apples of the world. Its hard work in 1985 produced the ARM1, and to try and put its achievement into scale, Acorn Computers produced a fully functioning 32-bit CPU with just 25,000 transistors running at 8MHz. The original Intel 8086 has 29,000 and was an eight-bit CISC processor – contrast that to the Intel 286, which itself had 134,000 transistors and ran with a similar performance to the ARM2.

Even so, ARM could have disappeared along with Acorn Computers. However, a small US manufacturer called Apple decided it needed a low-power processor for a new PDA called the Apple Newton, and ARM Holdings was created in 1990 with investment from VLSI Technologies. The ARM architecture needed additional work, such as an integrated memory management unit and full 32-bit address-space support.

This culminated in the release of the ARM6 running the ARMv3 architecture in 1992, which is effectively what’s largely used today, only with an increased transistor count up to 36,000. That’s for the basic core – tacking on the MMU and 4KB cache increases this count to around 360,000. The ARM610 was at the heart of the Apple Newton released in 1993 and also licensed by DEC to make the StrongARM. While the Apple Newton might have died off, its investment in ARM didn’t.

By 1998 ARM partners were shipping 50 million ARM-powered devices. In 2001 ARM had 76-percent of the 32-bit embedded RISC market and had 25 companies licensing its technology. By 2002 ARM partners had shipped more than 1 billion cores. By the end of 2019 ARM had shipped over 160 billion cores in total and 6.4 billion in the 4th quarter of 2019.



Simpler times

As we’ve alluded to, it’s not going to be an x86-based processor. As you know, Apple makes the iPhone, which it turns out is rather popular. They also tend to be the fastest phones on the market, by quite some way. It could use whoever designs those mobile processors to come up with something for its desktop systems! Who designed those processors again? Apple, using the ARM-licensed Instruction Set Architecture (ISA).

For those that don’t know, ARM is a Reduced Instruction Set Computer (RISC), whereas x86 that is a Complex Instruction Set Computer (CISC).

Just to touch upon the background, the design philosophy behind RISC is to optimise the instruction set, to ensure instructions can be run in a single memory cycle and to eliminate unnecessary instructions to an optimised core. As time has progressed, instruction sets have grown, especially with specialised

ARM mobile processors

YEAR	MODEL	CPU	FREQUENCY	ARCHITECTURE	CORES (LITTLE)	TOTAL CPU CACHE	GEEK BENCH 2 (32-BIT)	GEEK BENCH 3	GEEK BENCH 4	GEEK BENCH 5	GEEK BENCH 2 (32-BIT)	GEEK BENCH 3	GEEK BENCH 4	GEEK BENCH 5
							SINGLE CORE RESULTS				% INCREASE (GEN ON GEN)			
2007	IPHONE 1	SAMSUNG	412 MHZ	ARM11	1	32 KB	135							
2009	IPHONE 3GS	SAMSUNG	600 MHZ	CORTEX A8	1	320 KB	280	150			107%			
2010	IPHONE 4	APPLE A4	800 MHZ	CORTEX A8 HUMMINGBIRD	1	576 KB	378	206			35%	37%		
2011	IPHONE 4S	APPLE A5	800 MHZ	CORTEX A9	2	1,064 KB	617	215			63%	4%		
2012	IPHONE 5	APPLE A6	1.3 GHZ	ARMV7-A SWIFT	2	1,064 KB	617	712	754		156%	231%		
2013	IPHONE 5S	APPLE A7	1.3 GHZ	ARMV8-A CYCLONE	2	5,128 KB	2,224	1,401	1,266	259	41%	97%	68%	
2014	IPHONE 6	APPLE A8	1.4 GHZ	ARMV8-A TYPHOON	2	5,128 KB	2,421	1,599	1,459	308	9%	14%	15%	19%
2015	IPHONE 6S	APPLE A9	1.8 GHZ	ARMV8-A TWISTER	2	11,128 KB	2,985	2,506	2,382	541	23%	57%	63%	76%
2016	IPHONE 7	APPLE A10	2.3 GHZ (1.05 GHZ)	ARMV8.1-A HURRICANE	2X2 (ZEPHYR)	7,128 KB	2,985	3,427	3,444	741	20%	37%	45%	37%
2017	IPHONE 8	APPLE A11	2.4 GHZ (1.XX GHZ)	ARMV8.2-A MONSOON	2X4 (MISTRAL)	8,064 KB		4,269	4,212	919		25%	22%	24%
2018	IPHONE XS	APPLE A12	2.49 GHZ (1.5 GHZ)	ARMV8.3-A VORTEX	2X4 (TEMPEST)	8,256 KB		4,773	4,795	1,106		12%	14%	20%
2019	IPHONE 11	APPLE A13	2.66 GHZ (1.82 GHZ)	ARMV8.4-A LIGHTNING	2X4 (THUNDER)	28,000 KB			5,471	1,325			14%	20%

Intel desktop processors

YEAR	MODEL	CPU	FREQUENCY	ARCHITECTURE	CORES (LITTLE)	TOTAL CPU CACHE	GEEKBENCH 4	GEEKBENCH 5	GEEKBENCH 4	GEEKBENCH 5
							SINGLE CORE RESULTS		% INCREASE (GEN ON GEN)	
2009	CORE I7	860	2.8 GHZ	NEHALEM	4 (8)	9,024 KB	2,188	508		
2010	CORE I7	970	3.2 GHZ	WESTMERE	6 (12)	13,536 KB	2,652	594	21%	17%
2011	CORE I7	2600K	3.4 GHZ	SANDY BRIDGE	4 (8)	9,024 KB	3,014	811	14%	37%
2012	CORE I7	3770K	3.5 GHZ	IVY BRIDGE	4 (8)	9,024 KB	3,904	866	30%	7%
2013	CORE I7	4770	3.4 GHZ	HASWELL-DT	4 (8)	9,024 KB	4,261	910	9%	5%
2014	CORE I7	5820K	3.3 GHZ	HASWELL-E	6 (12)	16,536 KB	4,533	917	6%	1%
2015	CORE I7	6700	3.4 GHZ	SKYLAKE-S	4 (8)	9,024 KB	4,661	979	3%	7%
2016	CORE I7	6800K	3.4 GHZ	BROADWELL-E	6 (12)	16,536 KB	4,714	918	1%	-6%
2017	CORE I7	7700	3.6 GHZ	KABY LAKE-S	4 (8)	9,024 KB	5,193	1,061	10%	16%
2018	CORE I7	8086K	4.0 GHZ	COFFEE LAKE-S	6 (12)	13,536 KB	6,423	1,335	24%	26%
2019	CORE I7	9700KF	3.6 GHZ	COFFEE LAKE-S	8 (8)	14,048 KB	6,760	1,340	5%	0%

YEAR	MODEL	CPU	FREQUENCY	ARCHITECTURE	CORES (LITTLE)	TOTAL CPU CACHE	GEEKBENCH 4	GEEKBENCH 5	GEEKBENCH 4	GEEKBENCH 5
							SINGLE CORE RESULTS		% INCREASE (GEN ON GEN)	
2009	CORE I5	750	2.67 GHZ	NEHALEM	4	9,024 KB	2,297	500		
2010	CORE I5	650	3.2 GHZ	WESTMERE	2	4,512 KB	2,305	519	0%	4%
2011	CORE I5	2300	2.8 GHZ	SANDY BRIDGE	4	7,024 KB	2,859	599	24%	15%
2012	CORE I5	3330	3.0 GHZ	IVY BRIDGE	4	7,024 KB	3,110	656	9%	10%
2013	CORE I5	4430	3.0 GHZ	HASWELL-DT	4	7,024 KB	3,646	757	17%	15%
2014	CORE I5	4460	3.2 GHZ	HASWELL-DT	4	7,024 KB	3,720	797	2%	5%
2015	CORE I5	6400	2.7 GHZ	SKYLAKE-S	4	7,024 KB	3,963	834	7%	5%
2017	CORE I5	7400	3.0 GHZ	KABY LAKE-S	4	7,024 KB	4,476	884	13%	6%
2018	CORE I5	8500	3.0 GHZ	COFFEE LAKE-S	6	10,536 KB	5,243	1,074	17%	21%
2019	CORE I5	9500	3.0 GHZ	COFFEE LAKE-S	6	10,536 KB	5,524	1,143	5%	6%

Geekbench Scores: <https://everyl.com/ibenchmarks/index-ipod-iphone-ipad-benchmarks.html>
SoC Specifications: https://blakespot.com/ios_device_specifications_grid.html

cryptography/vector/SIMD functions. So the “reduced” part is now misleading.

There are interesting consequences from those design decisions. Optimising the instruction set reduces the number of transistors being used, and that reduces the amount of power required to do anything. So x86 and its CISC design inherently requires more transistors to do any computational job and so more power. On desktop this isn’t much of an issue, but with laptops and phones every watt counts.

This is why Intel’s half-bothered (sure, you can argue) stab at the phone market failed, which, considering it does networking, you’d have thought would be a no-brainer. Its x86 Atom offerings were too power-hungry and didn’t offer enough speed to differentiate the phones that used it. If Intel had backed it with more up-to-date process technology the story could have been different, but understandably it wanted to protect its core business.

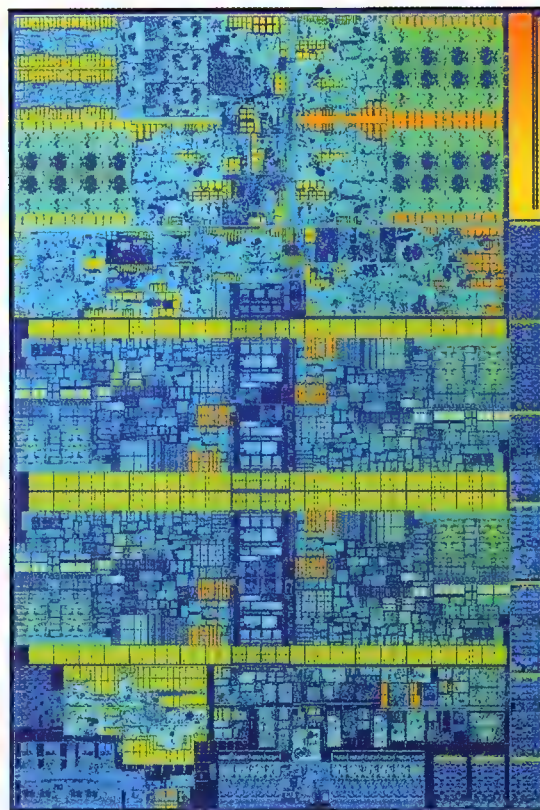
Join the Army

We’re going to look at how both the ARM architecture and Intel desktop processors have improved over time (which is charted on the previous page). It’s notoriously hard to correctly compare two different architectures, so we’re not, we’re just going to look at Geekbench

results as best we can. For ARM, we’re going to look at scores through the lens of Apple cores (used in just the major iPhone releases) as they’re the most performant, while for Intel we’ll focus on base Core i5 and Core i7 models in corresponding release years. We’ll keep an eye on the percentage speed increases. Alongside this we’ll delve into the major changes in the architecture – mainly on the ARM side, but it never hurts to go back over the Intel updates.

ARM is an IP company that designs the specification for the ARM ISA and updates it with new technology, such as its big.LITTLE core design, NEON SIMD instructions, and enhanced floating point units, for example. Typically it gives each new family release – the overall package of features – a name, such as Cortex-Ax; for Apple this started with the 32-bit ARMv7 within ARM11, and moves to designing its own micro architectures using the various updates to the 64-bit ARMv8.

In the original iPhone, Apple used a Samsung-designed SoC that was based on ARM11, which was actually introduced in 2003 using the ARMv6 microarchitecture. This was designed with early phone use in mind and introduced the first SIMD (Single Instruction Multiple Data) instructions for MPEG playback, improved cache (just



The 2015 Sky Lake architecture has been pottering along since 2015.

32K), and an eight-stage pipeline. With limited out-of-order execution and branch prediction, the performance can’t be taken as anything but weak.

The iPhone 3GS was the first really usable iPhone (in terms of software features). It stuck with a Samsung-designed SoC, but this used the updated Cortex-A8 core. Benchmarking shows a 107 percent increase in speed – put this down to the introduction of a dual-issue, superscalar 13-stage pipeline, backed with a 10-stage NEON SIMD pipeline for media acceleration. It doubled the L1 cache and introduced 256K L2 cache, and included a floating point unit. It’s this sort of “low-hanging fruit” that ARM and Apple was able to easily leverage at these early stages to drive doublings in speed.

The Apple A4 was the first in-house designed SoC, and while it debuted in the original iPad at 1GHz it was also used later in the iPhone 4, but at 800MHz. If Apple did Intel’s Tick-Tock design, this would be a Tock release. Still based on the Cortex-A8 architecture and the same Samsung 45nm process, it largely offered speed improvements via a clock increase and larger 512K L2 cache, but a key change was doubling the memory bus to 64-bit.

When Apple launched its iPad 2 it again introduced its all-new SoC – the Apple A5 at 1GHz – here first,

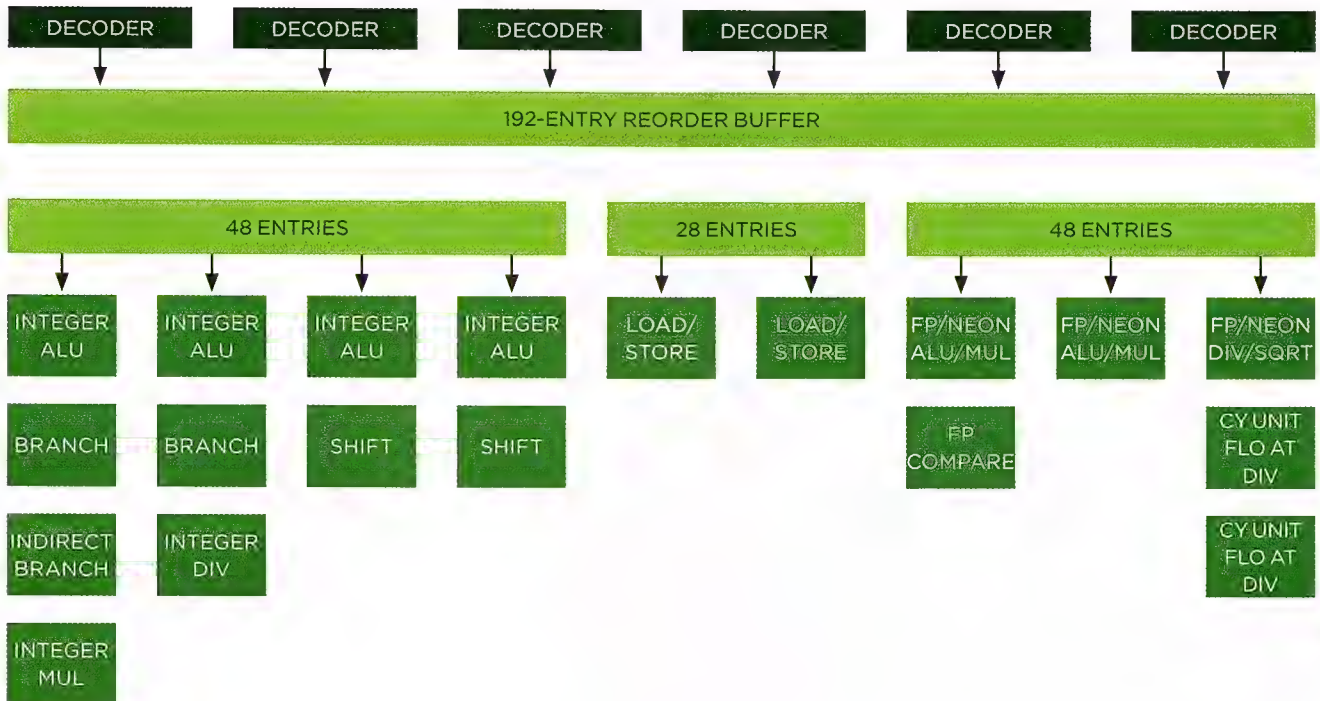
High-performance computing

We hardly have to feel bad for ARM, it’s not like it already owns the entire mobile phone and tablet space. In fact if things weren’t already looking a bit grim for Intel on the desktop and laptop front, consider that its cash cow of the server market is now under attack not by just a revitalised AMD but ARM as well. Server farms for decades have grappled with the issue that cooling costs more than running the darn servers, two-to-one back in the day, and even now one-to-one costs are a mark of a good cooling design. So if someone appears offering a way of reducing the power consumption of your servers you’re going to pay attention. That’s exactly what ARM has been busy doing.

You might have heard of Amazon and its Amazon Web Services that runs half the web. With so much bare metal to pay for, anything that saves on energy will benefit Amazon. So it designed its own server processor core called Graviton, and in 2020 released Graviton 2. It’s a 64-core SoC with 42MB of cache, running at 2.5GHz with eight-channel DDR4-3200 memory and 64 PCIe v4 lanes on the 7nm TSMC process. Estimates put power use at 100W vs 210W for a similarly pegged Xeon processor.

If that wasn’t enough, the all-new Japanese Fugaku system has taken the top spot for supercomputing power, besting the PowerPC/Tesla-powered Summit system by 2.8x with a whopping 415.5 petaflops – but can it play *Crysis* using Fujitsu’s 48-core A64FX Arm-based SoC? The UK’s national meteorological office is also planning to go ARM with another supercomputer that should claim the number-three spot once up and running in August 2022, offering 145 petaflops – enough to predict the weather before it happens!

APPLE CYCLONE



and into the iPhone 4S later at 800MHz. The Apple A5 was a significant release for Apple; it switched to the updated Cortex-A9 design, and it was the first dual-core release. Using the same Samsung 45nm process, the clock wasn't increased, but the memory speed doubled to 400MHz, and the L2 cache doubled again to 1MB. The Cortex-A9 also introduced more fundamental key improvements, such as an eight-stage out-of-order speculative pipeline, enhanced NEON SIMD and double-speed FPU.

The release of the Apple A6 was when things started to get interesting from the point of view of Apple taking charge of its own design future and using its own ARMv7 design tricks. The Apple A6 was the last 32-bit design from Apple, and while it used the same size L1 and L2 cache as the A5, a process drop to 32nm, clock boost to 1.3GHz, and clever architectural introductions offered one of the biggest gen-on-gen increases, all the while using less power. The A6 appears to be based on the Cortex-A9 but used advanced parts of the Cortex-A15 design, including two of its (then) new v4 FPUs and Advanced SIMD v2. Analysis indicates it could issue three commands and use five execution units (2 ALU, 2 FPU/NEON, 1 load/store) with a 12-deep pipeline. This massively

Moving to 64-bit ISA and a super-wide design for Cyclone.

enhanced the A6's FPU prowess, and with optimised cache and a dedicated load/store unit, memory performance increased threefold, and overall speed doubled, again.

At this point Apple hit its stride, and the Apple A7 release was another mobile first: A 64-bit processor almost a year before anyone else. Using the ARMv8-A architecture on a Samsung 28nm process Apple added a 4MB L3 cache, doubled L2 to 1MB and L1 to 128KB. Apple basically doubled the width of its processor with this release: six-issue wide, four ALUs, two load/store units, two branch units, and three FPUs/NEONs units. With a billion transistors, that's up 33 percent on the A6. For benchmarking we see the 32-bit only Geekbench 2 start to get long in the tooth, but Geekbench 3 points to the A7 Cyclone cores being twice as fast, again!

The Apple A8 remains a head-scratcher in terms of speed; it feels

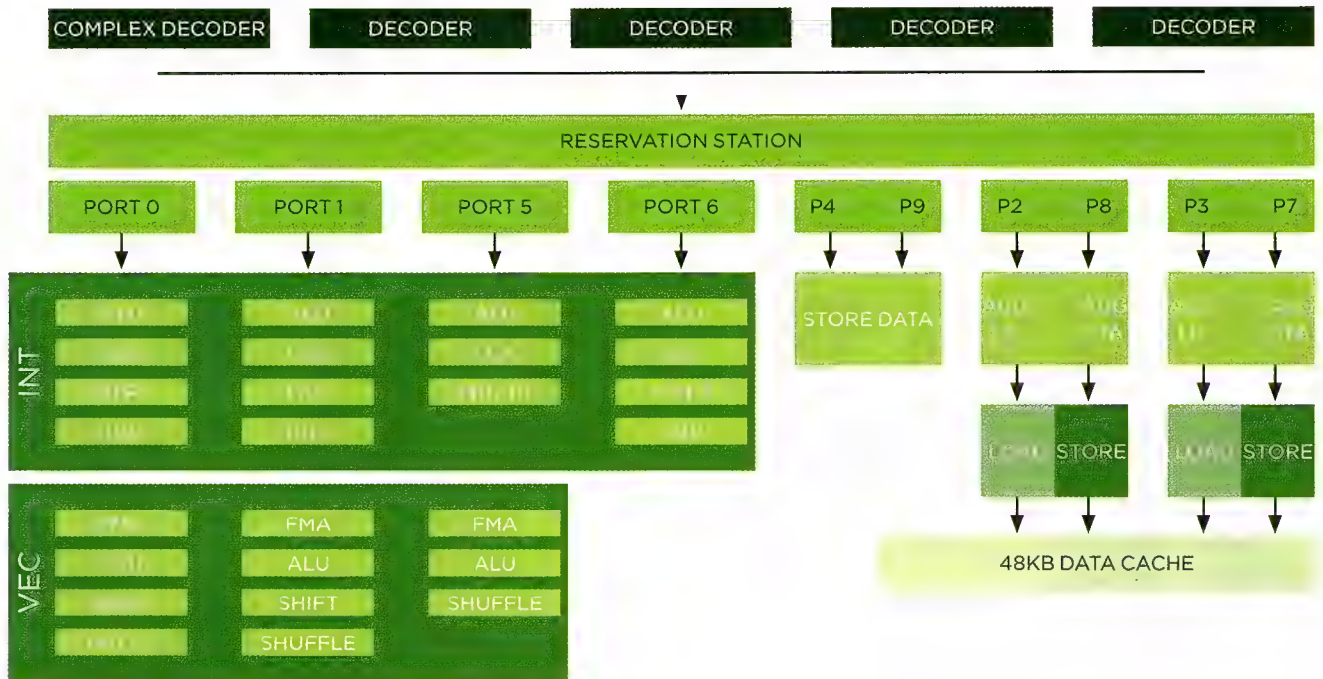
like Apple concentrated more on the GPU side – introducing an in-house custom GPU shader – and perhaps the shift from Samsung (now an arch rival) to TSMC on a new 20nm process was another distraction. It's a similar situation for the Apple A9 release, but utilising the TSMC 18nm and Samsung 14nm processes Apple could bump the clock to 1.8GHz, and tripled the L2 to 3MB.

The two big shifts for the Apple A10 were the introduction of the ARM big.LITTLE technology that enabled high-power and low-power cores to balance power consumption, plus a drop to the TSMC 16nm production. The easy win here was a jump to 2.3GHz speed, made easier with the introduction of the two low-power Zephyr cores, which ran at 1GHz and used just 20 percent the power of the "big" cores. Apple also moved to the newer ARMv8.1-A microarchitecture, though this was

Expect to see more Windows-running ARM systems using Qualcomm SoC.



SUNNY COVE



an incremental update. This was the last Apple SoC to get a Geekbench 2 result, and we'd think all the increase is down to the clock increase, while newer Geekbench releases also include GPU elements that continued to increase significantly in speed.

The Apple A11 introduced a 2x big and 4x little core, it seems the small Mistral cores in the A11 were actually based on the Apple A6 Swift cores. Unlike in the A10, these could now work independently of the big cores – previously it was either or could be used. The big Monsoon cores were a major update in terms of the mid-core, moving from the six-wide decode to seven-wide. While in the backend was the addition of two integer ALU units, upping them from four to six units.

The Apple A12 was another advance for Apple, being the first commercial 7nm silicon. A big change was made to how the processor cache was organised, helping reduce latency and increase bandwidth. The general L3 cache was dropped in favor of an 8MB L2 system cache, and the L1 was doubled to 256K. The configuration was a little more complicated, split differently between the big, LITTLE cores – the A12 had two large and four small cores, and the small Tempest cores were Apple A6-based Swift cores.

The big Vortex cores actually had a single-thread turbo to 2.5GHz. The A11 and A12 were very wide

architectures, even for desktop-class processors. With two complex units, two load/stores, two branch units, three FP/Vector units, that's potentially 13 execution units.

The current, latest Apple A13 sees Apple doubling down on its new cache system, now called System Level Cache, which gets a whopping 16MB to service the SoC. The little (Thunder) cores get 4MB L2 and the big (Lightning) cores get 8MB L2. The overall design of the A13 appears to be a similar seven-wide decode front end with improvements to the multiplier and integer units. The seven percent boost to clock speed doesn't account for the 14 to 20 percent speed increase Geekbench returns, even taking into account the 20 percent increase in the GPU.

There's no doubt that Apple is going to compete with Intel on the desktop; its processor design is as wide as a desktop design, and its System Level Cache is as large and efficient, but it's important to remember that this is unique in terms of ARM licensees. Apple is able to design such expensive silicon as it knows it's going to sell them in premium-priced products. It'll deliver better battery life and own another chunk of its device's costs, knowing it'll recoup its investment.

For 3rd-party processor manufacturers that model just isn't possible. Take AMD: It's never been able to compete with Intel and struggles even now when it's doing

The current Sunny Cove is the first major Intel architecture update since Sky Lake.

well. So is an ARM-based processor manufacturer going to swan in and take over the desktop (or even laptop) market from Intel and AMD? No – on desktop where power consumption isn't an issue and price is competitive, it'd be hard for anyone ARM-based to get a foothold.

Where ARM systems are targeting x86 is on mobile. Take the latest Lenovo Flex 5G that runs a Snapdragon 8cx SoC. We don't have specifics on the SoC itself, but it uses the Cortex-A76 microarchitecture that is a four-way frontend decode, nine-port issue that has three ALUs, two FPU/SIMD units, two Load/Store units, and a Branch unit. While certainly capable, it's a fraction of what Apple is putting into its current-gen silicon, and that plays out in the Snapdragon Geekbench 5 single-core result of 716, less than half of the Apple A13. The Snapdragon is a quad-core part but ends up slower than the Apple A13.

With Intel stumbling over its process technology once again, Apple is at least matching its best core designs for performance, while ARM's licensed cores are set to challenge Intel Core i5-level mobile cores. With AMD squeezing workstation and performance parts, ARM is being deployed in the lucrative HPC (high-performance computing) and server arena. There's zero argument about it – Intel is getting squeezed from every direction. ■

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BUILD IT

The Video Editor PC

Build yourself a desk-friendly videographer's machine, with Christian Guyton.

High-end videography work (whether that's live streaming, post-production editing, or something else entirely) often demands a powerful PC. 4K video editing, exporting, and encoding are all resource-intensive tasks, and trying to do them with a sub-par or ageing machine is sure to lead to lengthy processing times and general frustration.

Such powerhouse machines are also often pretty chunky. It's part of the reason that Apple's desktop products have become successful within the creative industry; the all-in-one form factor of Macs is a great space-saver, tucking a purpose-built compact machine away behind a large monitor. But for those who prefer PCs, a system that can comfortably handle demanding video tasks is often going to be large, heavy, and potentially quite loud.

Such machines either take up a significant amount of available desk space or need to be placed underneath the desk itself, making cabling and access a hassle as well as potentially worsening airflow, since the system is closer to the floor. Fortunately, your friendly neighborhood computer magazine is here to show you how to make a

videography machine that has both a compact desktop footprint and a ton of powerhouse components.

Whether you would choose PC over Mac for software and OS reasons or just the superior customisability of PC hardware, there are a few benefits to consider here. Windows is obviously one of them; the world's most widely used operating system is ideal when it comes to compatibility and familiarity. We're deviating from the norm, though. You'll notice in our list of ingredients that we've opted for Windows 10 Pro, the more powerful version of Microsoft's flagship OS. It's also more expensive than Windows 10 Home, so if you don't need the Pro upgrade, consider it merely a suggestion.

Pro's main benefits are improved security (with BitLocker encryption) and a suite of various enterprise features; it's up to you to decide whether you actually need that in your professional capacity. This isn't a cheap system, so if you want to save some cash you can buy Home.

Now, without further ado, let's take a look at the physical parts we're using to build this system.

PART		STREET PRICE
CASE	NZXT H1 BLACK	\$635
M/BOARD	MSI MPG B550I GAMING EDGE WIFI	\$349
CPU	AMD RYZEN 9 3950X	\$1,169
CPU COOLER	140MM NZXT H1 INTEGRATED AIO COOLER	N/A
MEMORY	64GB (2X32GB) HYPERX PREDATOR DDR4 @ 3200MHZ	\$459
GPU	NVIDIA GEFORCE RTX 2080 SUPER FOUNDERS EDITION 8GB	\$899
PSU	650W NZXT S650 INTEGRATED PSU	N/A
SSD	2TB CORSAIR FORCE MP600	\$790
OS	WINDOWS 10 PRO	\$180
TOTAL		\$4,481

"Whether you would choose PC over Mac for software and OS reasons or just the superior customisability of PC hardware, there are a few benefits to consider here."

Motherboard

MSI MPG B550i Gaming Edge WiFi

\$349

The new B550 chipset is changing the game when it comes to AMD machines. Previously, if you wanted to take advantage of the blazing fast PCIe 4.0 SSDs, you needed an X570 motherboard, which was undeniably expensive – especially if you were looking to build a more affordable system with a cheaper Ryzen 3000 processor. The B550 line is a solid upgrade to the similarly budget-conscious B450 chipset, and this MSI board packs all the features we'll need into a compact ITX form factor. Shifting down to an ITX motherboard doesn't have to come with a noticeable drop in performance; we've picked the best components to work with this motherboard.



Case

Nzxt H1 Black

\$635

That's a lot of money for a case! Don't worry, though, it's justified. The Nzxt H1 is the entire basis for this build: A super-compact ITX tower with an incredibly small footprint. How does it achieve such slenderness? Integrated components, that's how. Part of that price tag is allocated to the 80+ Gold-rated Nzxt S650 power supply, a small but mighty PSU mounted at the top of the case to save space. An AIO cooling solution is also included, routing heat away from the motherboard to a 140mm radiator and single fan. Heat buildup shouldn't be a problem here, though; the H1 has three sides with a perforated design that ensures good airflow at all times. There's even a PCIe riser strip for you to vertically mount your PSU, guaranteeing optimised use of the available space. Oh, and the H1 looks awesome and feels robust, with a frame of solid steel and a tall tempered-glass window.

"The NZXT H1 is the entire basis for this build: A super-compact ITX tower with an incredibly small footprint."

CPU

AMD Ryzen 9 3950X

\$1,169

The core of this machine is AMD's most powerful Ryzen chip, the Ryzen 9 3950X. The arrival of the 4th generation of desktop Ryzen chips is still a matter of debate, with leaks and rumours swirling, and the recent announcement of powered-up "XT" variants of the 3600X, the 3800X, and the 3900X. For now, though, this 16-core beast remains at the top of the table. A whopping 4.7GHz max boost and a tonne of cache memory makes this a content-creation powerhouse as well as a top-notch gaming CPU, and AMD's SMT technology means we've got 32 threads to play with as well. Combined with a powerful GPU, this chip should blast through most video-editing tasks and run cool thanks to a 105W TDP and its 7nm architecture.

"A whopping 4.7GHz max boost and a tonne of cache memory makes this a content-creation powerhouse as well as a top-notch gaming CPU"

CPU Cooler

140mm Nzxt H1 AIO cooler

N/A

As we mentioned earlier, the H1 case from Nzxt comes with a CPU cooler and power supply built into its chassis. These are both removable, but that's a challenging process, and it's also unlikely you'll want to use anything else; this is a high-quality AIO cooler with a 140mm Nzxt fan and tubing that is exactly the right length for zero in-case slack. The single radiator is set up in conjunction with other components to promote a specific dual-chamber airflow setup, where cool air is drawn in from both sides and expelled through the perforated rear panel. It's an elegant solution for compact cooling, and the pump plate is equipped with a bracket that makes it compatible with both AMD and Intel ITX motherboards.



SSD

2TB Corsair Force MP600

\$790

Okay, we might've gone a bit overboard spending money on this build. But the Force MP600 is still our favorite PCIe 4.0 drive: reliable, stupidly fast, and the attached heat sink is nice and easy to remove. When connected to a supported motherboard and CPU, this M.2 SSD reads data at almost the holy 5GB/s, and it's actually one of the more affordable 2TB drives with PCIe 4.0 compatibility. The M.2 format means there's no cables to worry about either, which is a plus in such a cramped build. Corsair guarantees that the MP600 will write up to 3,600TB of data before you ever have issues with reliability, so it's simply the best 4th-gen M.2 SSD around – at least, until the looming titan that is Samsung releases its own competition...



GPU

Nvidia GeForce RTX 2080 Super Founders Edition 8GB

\$899

The professional ethos certainly applies to our GPU, the RTX 2080 Super FE. Nvidia's stripped-back aesthetic looks great, particularly the ultra-shiny mirrored centerpiece. The most RGB you'll get here is the GeForce RTX text along the side of the card, which lights up a bright green. Of course, the Founders Edition model of this top-notch GPU is something of a rare find at this point, so you will probably have to opt for a third-party manufacturer version – and that's all assuming the new RTX 3080 isn't an option for you. Factory overclocked cards can perform better than FE models, and might come with software or aesthetic choices that you prefer. Be wary, though, as the H1 has very little room to mount a graphics card. Triple-fan cards are obviously not an option, but even some twin-fan GPUs will be too bulky for this case. Do your research first.

"Factory overclocked cards can perform better than FE models, and might come with software or aesthetic choices that you prefer."



PSU

Nzxt S650 80+ Gold

N/A

A simple but high-quality component, the S650 is a conventional SFX-L power supply, with a fully modular design and pre-routed cables inside the Nzxt H1 case for minimal clutter. If you were to build an integrated-graphics system inside this case, you could strip away even more of that cabling. The S650 is (as its name implies) a 650-watt power brick, which should be more than capable of supporting our system and leaves some headroom for upgrading in the future too, in case you decide to bump up the GPU or add extra storage. Interestingly, even though the H1 case and cooler come with a three-year warranty, the S650 retains Nzxt's standard warranty for power supplies: A whopping 10 years of coverage.

"The S650 is (as its name implies) a 650-watt power brick, which should be more than capable of supporting our system and leaves some headroom for upgrading in the future too"

Memory

64GB (2x32GB) HyperX Predator DDR4 @ 3200MHz

\$459

This is technically two items, though they'll be doing the same thing. From what we can gather, HyperX doesn't sell this exact memory kit (with a CAS latency of 16 – a similar CL18 kit is available), but you can simply buy two of the 32GB 3200MHz Predator sticks separately. As long as they are identical, these should work together fine; our MSI B550i motherboard has two DIMM slots and can support a total maximum of 64GB of RAM, so it works out well. This speedy, high-capacity memory will give our machine the extra oomph it needs to power through video editing or 3D animation tasks. You'll notice a conspicuous absence of RGB lighting here, and we're going to stick to that. This is a professional build, not a flashy one.

"This speedy, high-capacity memory will give our machine the extra oomph it needs to power through video editing or 3D animation tasks."



BUILD IT

Small but MIGHTY

A tidy, professional videography workstation

Length of time: 2-3 hours | Level of difficulty: Medium



01 SHIELDS DOWN

Let's kick things off with a case stripdown. The cooler and PSU come screwed into the case, and cables are pre-routed, so there's no need to mess with them. First pop out the front glass panel and rear perforated panel. These secure the U-shaped metal casing that forms the top and side panels of the case; once they are free, it should simply lift off the frame. Carefully remove the polystyrene that's cushioning the AIO cooler.

That's all you need to do for now; removing the side panels is a completely screwless process, so ignore the tiny screws around the frame. The entire case can be disassembled (the long edges of the frame are plastic struts secured with Phillips-head screws), but that won't be necessary for this build.



02 RADIATOR RELEASE

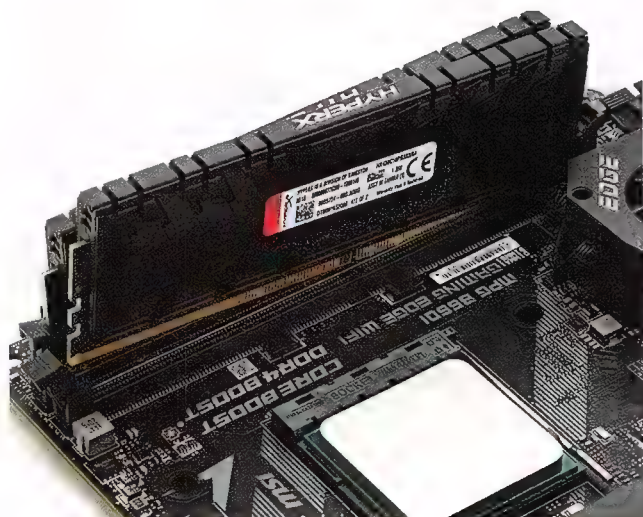
At first, it seems impossible to install a motherboard inside this case without removing the bulky 140mm radiator and fan entirely. Fortunately, NZXT has a nifty solution for this. Two screws at the top of the bracket securing the radiator are clearly labelled (with arrows cut into the metal!), and removing these allows the entire AIO cooler to flop down out of the case via a concealed hinge. Situate the case in an upright position and be careful when releasing the second screw, as gravity will act fast and you don't want to damage the radiator. Make sure that the CPU block and pipes are also clear of the case, but don't bend the pipes too much, as these short tubes aren't as flexible as those on larger AIO coolers.



03 MOTHERBOARD READY

Let's get this board prepped. If you buy a new unit, the MSI B550i board should come with the standard AM4 cooler bracket (a plastic "hook" bracket on either side of the processor) already fitted around the CPU socket. If not, install that first.

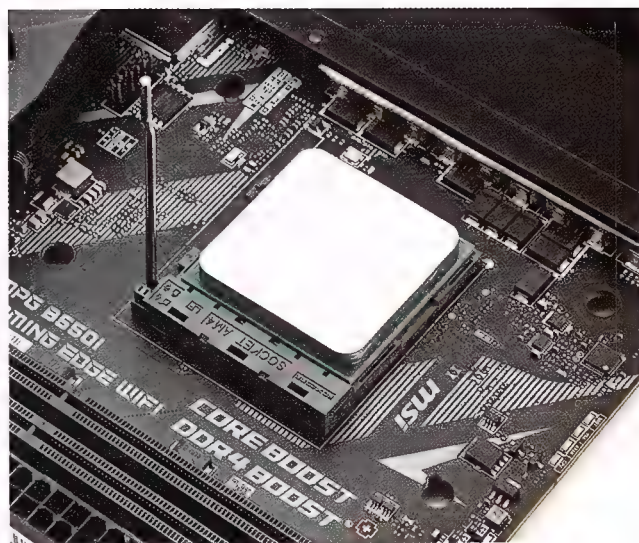
This is easy enough to do; position the metal backplate beneath the motherboard so that the four screw holes line up with the four holes around the socket, then attach the two plastic brackets with the provided screws. Each bracket's "hook" should be pointed away from the processor if fitted correctly. Place your motherboard on the box it came in (or, if you have a dedicated antistatic building space, use that) and you're ready to start installing components.



05 THE RAM'S HORNS

There's only two DIMM slots available on this B550 board, so you don't have to worry about picking the right slots for full memory speed. Release the clasps on the slots and push each stick of memory into place until it clicks, both at the clasp end and the opposite end. Both clasps should be secured, and the memory should sit flat in the slot. We are going to have to mess about in the BIOS later to ensure that our memory is running at full speed, since it'll likely default to a lower frequency like 2,400MHz.

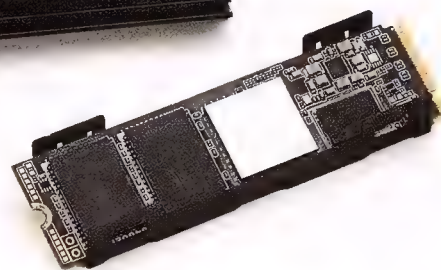
This motherboard and processor should support the full capacity without issue, so there'll be a hefty 64GB of RAM to play with once the system is up and running.



04 SOCKET ROCKET

Be gentle with the Ryzen 9 3950X. That's \$1,200 in a tiny slab of metal and silicon. Check that the pins are undamaged on any Ryzen CPU before trying to fit it to a motherboard, as a slightly bent but repairable pin may snap and render the whole chip unusable. No, we're not speaking from experience. Anyway... lift the metal retention arm on the CPU socket and carefully drop it into place, being sure to line up the gold triangle on the chip's corner with the triangle on the corner of the socket.

This 3950X is somewhat distinct from the other 3000-series Ryzen processors we've seen; the font is subtly different, and the gold triangle is smaller. Once the chip is in place return the retention arm to its original position.



06 LET THAT SINK IN

We'll be mounting the Corsair Force MP600 SSD on the motherboard, but first we're going to need to remove the heatsink that comes with it. This can be somewhat fiddly, so take care not to damage the SSD itself. The heatsink is held in place by a clasped metal bracket that also cradles the drive, but the drive is also stuck to the heatsink by a strip of adhesive thermal padding. You'll need to apply a bit of force to free the heatsink from the clasps, but the lower bracket's metal does flex a little, which should allow you to remove the sink and then peel off the bare drive. Do this last part slowly, as you don't want to tear the sticky padding and leave any bits of it stuck to the drive.



07 ARMORED UP

Once the SSD is all naked (oh my) you can install it to the motherboard. First, you'll need a small Phillips screwdriver to remove the M.2 heat shield on the board. Be careful when doing this, as it has its own tiny fan and is attached to the board via a thin cable. You don't have to disconnect this; just place the shield carefully on the board beside the M.2 slot.

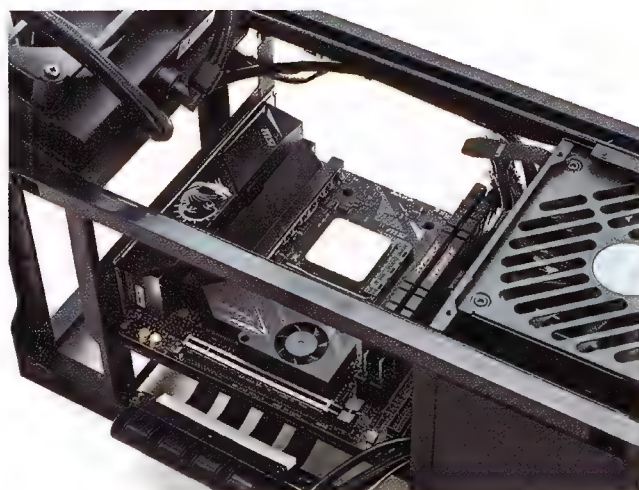
The B550i comes with two standoffs pre-installed; remove the one closest to the slot. Fit the M.2 drive and gently push it down so the other end rests on the correct standoff, and secure it with one of the tiny screws included in the box. Then, remove the protective plastic from the shield's sticky pad, and line up the screw holes before sticking it in place and screwing it down.



09 CABLE FABLES

Getting the cabling sorted is laborious. The twin PCIe power cables for the GPU should be partitioned separately into the cavity on the opposite side of the case, so leave them alone for now. Connect the pre-routed power cables to the motherboard, then the front I/O cables. Run these around the edges of the board, so that they don't get in the way when you fit the cooler and close the case. Use the velcro straps inside the case to keep the cables from resting on the motherboard components.

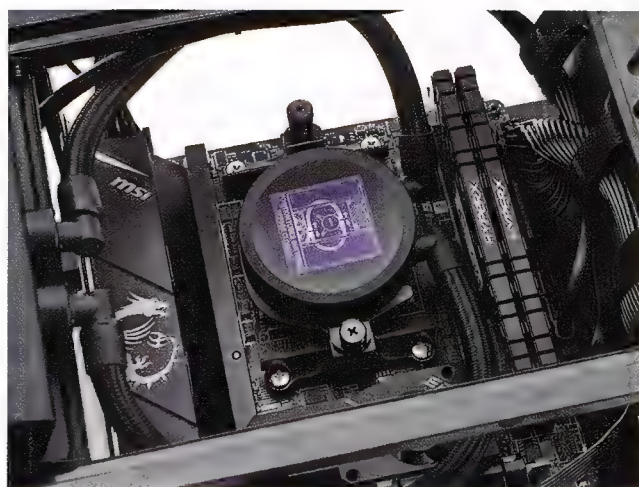
Since the H1 makes accessing the rear I/O tricky, you may want to leave those cables disconnected and invest in an external USB hub. Lastly, plug in the loose end of the PCIe riser. Curve it around the edge of the board to fit into the expansion slot.



08 MOUNTING RANGE

It's time to mount this motherboard. Even with the radiator out of the way, there's still little room to work here. Place the H1 on its side with the tiny motherboard plate facing upwards, and lower the motherboard assembly onto the four standoffs. These standoffs may be partially blocked by the pre-routed cables; be sure to move these so they won't be trapped underneath the board. The rear I/O shield comes pre-fitted, and it should line up with a slot on the underside of the case – more on this later.

The four screws needed to secure the motherboard are in the case accessories box. A long magnetic-tip screwdriver can make affixing these screws easier, as the cramped case makes getting your hands in close to the motherboard a challenge.



10 COOL WAVES

Let's get this cooler in place. The H1 comes with the Intel bracket pre-fitted, so remove that and replace it with the AMD version in the accessories box. This isn't complicated, but consult the H1's instructions for more detailed diagrams. The Intel bracket slides out from around the CPU block with a bit of force (the plastic casing may shift a little bit). Replace it with the AMD bracket, and attach the two clasps to either side with the long screws and sprung standoffs provided.

Once the bracket's ready, put a pea-sized blob of thermal paste on the processor and push the CPU block down over it, attaching it to the plastic "hooks" on both sides, then screw it down until it won't budge. Don't over-tighten it, though.



11 HINGE SCIENCE

With the cooler secured, it's time to get this radiator back into place. The hinged bracket lifts back up easily and only needs to be secured with the two screws removed earlier, but there's two things you need to deal with before you can do that.

First up is the pump and fan power cables; these plug in right next to each other on the motherboard. The three-pin pump connector can be plugged into the four-pin header. Secondly, the two AIO tubes need to be lowered into the case and curved outwards from the block – otherwise they won't bend safely when the radiator is returned to its original position. Place the case upright to fit the radiator, and hold it in place with one hand as you secure the first screw, otherwise it's liable to pop out.



13 CLOSING TIME

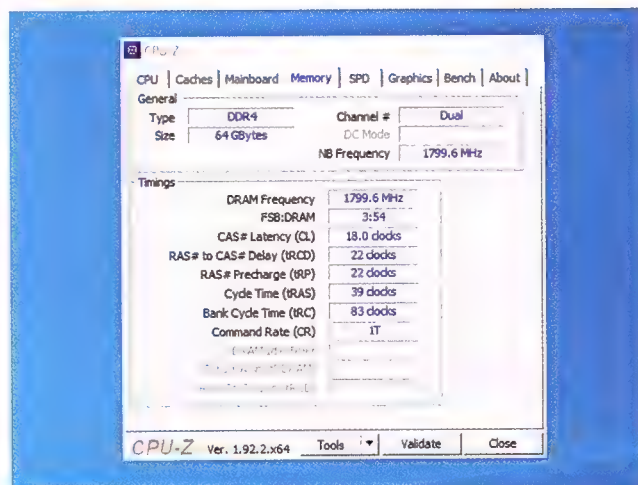
We're all done, so it's time to seal up this 2001-monolith-looking monster machine. Take a little time to tuck in any stray cables before closing the case. The large metal cover goes back on first, lining up with grooves on either side of the frame to slot back down into place over it. With that done, the rear panel and window pop back into place easily. All done!

Now, when setting this system up, you'll first need to put it on its side and plug in your network cable, display cable, and any USB peripherals that you're using. All of these cables can then be routed neatly out of the slot on the rear of the case once you place it upright once again.



12 VERTICAL REALITY

The PCIe riser should be fully secured, plugged into the mobo at one end and pre-fitted onto the frame at the other. Remove the two thumbscrews from the rear I/O slot (on the underside of the case). Turn the case sideways so the open end is facing upwards, and position the GPU inside the frame before lowering it into the slot. It should click into position, and the rear I/O should be flush with the rear opening on the case. For us this requires a lot of pressure on the card, but that might not be the case with every card. Hold the GPU in place while you replace the two thumbscrews. Once the card is secure, plug in the two PCIe power cables; only one eight-pin connector is needed, so strip away and coil the extra two-pin connector on the second cable.



14 UP TO SPEED

One last task before this system is ready to chow down on some delicious video files. That HyperX Predator memory won't run natively at 3,200MHz, so take a quick trip into the motherboard BIOS to rectify that. Thankfully it's nice and simple; fire up the BIOS by hitting F2 on boot, then turn on the first A-XMP memory overclocking profile. This should set the memory to the correct 3,200MHz frequency and give you full performance. To double-check, boot up the system proper and install Windows, then download CPU-Z from www.cpuid.com and check the memory tab. This should display half the speed, so if it says 1,600MHz, you're good to go!

Conclusions

A small machine that packs a big punch.

We're really pleased with how this system turned out, because building it wasn't easy. The Nzxt H1 is a fantastic case with a bunch of cool innovations that benefit its small form factor, but actually building in it is an exercise in cramped spaces and fiddly cabling. Were we to start afresh, we might wait until the motherboard cables are all in place before installing the memory, as it got in our way while we were trying to connect the ATX motherboard power cable.

Thankfully, though, once we closed the case up and plugged this bad boy in, it booted and ran perfectly straight away. Praise be! All too often we have to delve back in to rectify a little mistake that prevents a boot. Not this time around, though. We got our peripherals and monitor set up and boom, the pre-loaded copy of Windows 10 on the Corsair Force MP600 is up and running.

The first thing we noticed is the noise. Yes, this build isn't exactly quiet, although it obviously pales in comparison to bigger, beefier machines. The main offender here is the Nvidia RTX 2080 Super FE; the flat twin fans are quite loud,

though only when the card is running at load. We detect a faint bit of pump whine from the AIO cooler too, although the 140mm radiator fan seems to run quietly. The system makes very little noise when idling or during low-intensity tasks.

The Ryzen 9 3950X demolishes our benchmarks, as expected. This 16-core beast chews through CPU-bound tasks with ease, nailing great scores in Cinebench and Fry Render, among others. Gaming performance still lags a bit behind Intel, but this will only affect CPU-bound titles like *Total War: Warhammer II*. General graphical performance in games and real-time rendering is fantastic, which is no surprise given the powerful GPU we're using. However, a factory-overclocked model of the RTX 2080 Super from a third-party manufacturer is liable to perform better.

In fact, we had originally planned to use an MSI graphics card for this build. All was going well until we reached Step 12... then couldn't fit the GPU inside the case. We tried everything:

Removing the front I/O to clear some room, unscrewing the PCIe riser to plug it in before trying to mount the card, even disassembling the entire top half of the case. Nothing worked. But we'd checked the height clearance! Turns out that wasn't our problem, though. The card we had initially chosen was too wide for the space. Learn from our mistakes, dear readers – find a compact card.

All-round performer

Anyway... back to assessing this build's performance. It's great across the board, really: Renders are speedy, and file transfers are more or less as fast as you're going to get. The Force MP600 SSD gets mighty close to that coveted 5GB/s, although performance is a smidge lower than we were expecting: Probably because this B550 board can't handle the drive quite as well as a more expensive X570. Still, you're not likely to notice any difference in practice. The MP600 remains blazing fast, streamlining bulk data transfers and trivialising load times in games.

One area our system seemed to fall down on was memory performance. Although it wasn't bad, the bandwidth tested in AIDA64 was lower than we had hoped for, and the real-world latency wasn't exactly impressive either. Our memory was running at full speed (as confirmed by CPU-Z) and we double-checked

"The Ryzen 9 3950X demolishes our benchmarks, as expected. This 16-core beast chews through CPU-bound tasks with ease, nailing great scores in Cinebench and Fry Render, among others. Gaming performance still lags a bit behind Intel, but this will only affect CPU-bound titles like Total War: Warhammer II."

APC LABS BENCHMARKS

Indicates best result	Cinebench R15 Single	Cinebench R15 Multi	TechARP x264	Fry Render	AIDA64 Memory Bandwidth	AIDA64 Memory Latency	SSD 1: CrystalDisk QD8 Sequential Read
	Index	Index	fps	m:s	MB/s	ns	MB/s
Video Editor	214	3,985	79.09	1:10	38,961	93.9	4,924
Zero-point	192	2,952	61.08	1:17	55,051	71.4	4,992
	SSD 1: CrystalDisk QD8 Sequential Write	SSD 1: CrystalDisk QD1 Random 4K Read	SSD 1: CrystalDisk QD1 Random 4K Write	Adobe Premiere Pro 5-Minute 4K Render	Adobe After Effects 10-Second 4K Render	Total War: Warhammer II	3D Mark: Firestrike
	MB/s	MB/s	MB/s	m:s	m:s	fps	Index
Video Editor	4,252	46	237	1:11	5:27	46	24,539
Zero-point	4,284	60	220	1:19	6:14	54	21,453

Our zero-point consists of an AMD Ryzen 9 3900X, 32GB (4x8GB) G.Skill Trident Z RGB Neo @ 3600, an EVGA GeForce RTX 2080 Super XC Ultra, and a 1TB Corsair Force MP600 M.2 PCIe 4.0 SSD. All game tests were performed at 3440x1440 on Ultra.

that the MSI motherboard was definitely capable of fully supporting this RAM. This is our first time using a B550 board, and an ITX model at that, so it could be that these new budget boards just don't handle high-capacity memory too well. Alternatively, the problem could lie with the memory itself; broadly speaking, we'd recommend you buy a proper kit of two. HyperX did actually send us our two in a single box, but we couldn't find such a kit available anywhere online.

In any case, overall performance was solid. This system has all the hardware necessary to handle even the most demanding videography tasks from the comfort of your home office, and it certainly won't take up much space. Compared to the previous machine on our test bench (read: dinner table) – last issue's audio-recording build – the difference is night and day. The H1's smart routing means that the cables for our peripherals and monitor neatly run from the rear of the base. The OS boot speed is delightfully fast.

This system runs cool, too; pushing the processor to the limit didn't see much time spent in excess of 60C. That single-fan AIO is clearly working some serious overtime, doing plenty to justify the H1's overall price. The metal outer casing felt ice cold even after we'd blown through multiple repeated benchmarks, demonstrating that Nzxt's dual-chamber airflow design really works.

While we did play around with overclocking, the best option is simply to use AMD's Ryzen Master software for auto-overclocking. We were just about able to hit a stable 4.2GHz overclock manually, but the automated alternative reliably gave us 4.3GHz at load and is gentler on the processor. Auto-overclocking did still see a significant temperature increase, but nothing to be concerned by. Ryzen Master's primary benefit was in single-core performance, which is effectively lost if you choose to overclock manually.

Look to the future

There's some potential for upgrades here too. While a 2TB



01

The PSU is neatly cradled inside this metal shroud attached to the roof of the case. It can be replaced with a different SFX power supply, but be warned: It's a laborious process.

This particular GPU fits snugly in the allocated space, but those Founders Edition fans are certainly quite noisy when they're working hard.

Making the rear I/Os virtually inaccessible during normal use is a bold move on Nzxt's part, but if you prep your workspace well enough it shouldn't be a problem.

"The 2080 Super is a fairly future-proofed choice of GPU, but should you feel a burning desire to upgrade once the inevitable RTX 3000 series arrives, it won't be difficult to do so."

M.2 drive is nice, anyone who works with 4K video will know that it likely won't be enough in the long run, especially if you'd like to keep a few games on your system too (looking at you, *Call of Duty*). There's one extra aspect of the Nzxt H1 we've yet to mention: The toolless SSD tray. This makes installing an extra SATA SSD or two a cakewalk, and with Samsung promising cheaper 8GB 2.5-inch drives in the near future, we might consider calling time of death on HDDs in high-end systems.

Upgrading the graphics card is also a straightforward process, as it's only secured by two thumbscrews and a small clasp on the PCIe riser. The 2080 Super is a fairly future-proofed choice of GPU, but should you feel a burning desire to upgrade once the inevitable RTX 3000 series arrives, it won't be difficult to do so. The S650 power supply means that there's a reasonable amount of headroom when it comes to power.

Changing components like the SSD and processor will likely prove more challenging, but both are high-quality choices so we feel confident that they'll last a while. If you do need to upgrade the PSU to allow sufficient wattage for your upgrades, brace yourself for a challenge. The plastic frame of the case needs to be partially disassembled in order to detach the PSU shroud and access this compact power brick.

As a finished build, it doesn't look like much. The window of the H1 matte black edition is tinted, providing very limited views inside, but there's not much to see when it's removed anyway: Just the edges of the GPU and motherboard, and the solid black metal of the PSU shroud, with some black cables packed tightly around it all. That's perfect, though; this system oozes clean professionalism, and would look equally good in a small home study or an open-plan office. Mission accomplished. ■

System News

Nvidia's new 3000 series has Mark Williams excited for things to come.

When Jensen Huang, CEO of Nvidia officially revealed the RTX 3000 series at the start of September, it ushered in the hotly anticipated next generation of graphics cards we have been long waiting for.

It has been two years since the launch of the RTX 2000 series. While it was an improvement over the GTX 1000 series in that it brought us real time ray-tracing and DLSS for the first time, these were extras; niceties, or the cherry on the top of the meat and potatoes that is the raw rasterisation performance of a card.

With the RTX 2080 merely equalling the rasterisation performance of the now somewhat legendary GTX 1080 Ti, it came as a bit of a let down, as effectively for the same price as the GTX 1080 Ti the RTX 2080 was delivering the exact same performance two years on. It made zero sense to upgrade.

The RTX 2080 Ti was a genuine performance boost but at such crazy prices it was a tough sell.

Raytracing and DLSS game title support was non-existent at launch and even today we are far from seeing prolific adoption. It is quite the chicken and the egg problem. With no hardware support game developers won't make games that support raytracing, and without the games to run on the hardware, consumers aren't going to want to buy hardware that otherwise performs the same as their current cards.

But Nvidia has forged ahead and with the big DLSS 2.0 improvement rolled out, "RTX On" is becoming more and more relevant.

AMD has been stuck trying to break past GTX 1080 Ti levels of performance as well with its latest and greatest in the RX 5700 XT only able to match it at best. But AMD appears to be making great strides with its RDNA2 based graphics architecture found in both next gen consoles, with support for ray-tracing and all whispers pointing to "Big Navi", (which will be revealed in October), being faster than a RTX 2080 Ti, AMD should be within



"The RTX 3080 ... is a great generational improvement and finally gives GTX 1080 Ti owners something truly worth upgrading to."



MARK WILLIAMS
Mark is an IT professional with a strong interest in voiding warranties.

striking distance of the RTX 3080's raster performance.

According to some early benchmark results, the RTX 3080 is about thirty percent faster than the RTX 2080 Ti in raw rasterisation performance, which is a great generational improvement and finally gives GTX 1080 Ti owners something truly worth upgrading to.

The massive RTX 3090 though is quite an interesting beast of a card. Jensen Huang said it was a Titan-class product for the masses, yet it is not called a Titan and is priced just a little higher than the RTX 2080 Ti was. With 24GB of memory it's clearly aimed more towards productivity yet is

US\$1,000 cheaper than the previous Titan card, making it much more accessible to the masses, but for double the price of the RTX 3080 and with just twenty percent more CUDA cores, it's definitely on the wrong end of the price-to-performance scale gamers like to see.

It has taken four years for Nvidia to finally have made a step function improvement in performance. Now we just need to see what secret sauce AMD has been baking all this time into the next-gen consoles, and what that will eventually mean for its next generation of discrete graphics cards launching after October.

Shop Talk

What are your thoughts on the details from the RTX 3000 series announcement and what are your predictions for the popularity of the RTX 3090?



JAMIE, LEADER COMPUTERS:

"The dawn of a new graphics card generation.... Exciting times!

Our main concern is the performance of the 3070 being higher than the considerably more expensive 2080 current cards, it will make for some interesting conversations if Nvidia get stock into the country quickly. Judging from past launches though, there will be tight allocation constraints and the high expense of international airfreight currently

will offset some of that gap.

Demand for gaming rigs in general has been very strong, as many people normally spending on dining out, drinking in pubs and travelling have very little to spend their cash on. The 3090 cards look amazing, and with plenty of JobKeeper and JobSeeker money still in the economy we expect a rapid uptake this launch." ■

Market snapshot

A sampling of PC systems available this month.



\$2,388 | tinyurl.com/y5gnjd9j

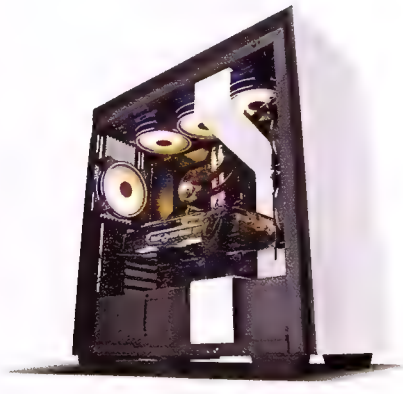
PLE Computers Apex Spitfire

This system is a little off kilter. For a gaming system, it will do well at 1080p with frame rates in the 70-100fps range in most titles. For this cost-tier of a system that really isn't great, but that's because PLE decided to focus most of the budget on CPU performance, so CPU heavy titles like *Assassins Creed Odyssey* will do better on this system.

Expect to upgrade the GPU sooner rather than later as it is the primary bottleneck here.

The storage subsystem could be better too. Consider dropping the HDD and upgrading the SSD to a 1TB NVMe option at check out for the same price for better load times and system responsiveness.

CPU: i5 10600K, **Cooler:** Sweden Series SE-224-XT, **Motherboard:** Asus TUF Gaming H470-PRO WiFi, **Graphics:** Asus GeForce GTX1660Ti Phoenix, **Memory:** Gell 16GB EVO SPEAR 2400MHz, **Storage:** Kingston A400 480GB SSD, Seagate Barracuda 2TB HDD, **Power Supply:** eVGA SuperNOVA G1+ 750W, **Case:** Cooler Master MasterBox K500 RGB



\$4,999 | tinyurl.com/y62uwofr

JW Computers GMR Apex 2080 Ti

Coming in at five grand at the time of writing, this is a beast of a machine, but by the time you read this it will be overpriced and underperforming, due to the RTX 2080 Ti being superseded by the just launched RTX 3000 series cards.

The RTX 3070 will match its performance at half the price with the RTX 3080 being even faster and still cheaper.

Needless to say, don't buy this system as it's currently configured unless you can get it altered to an RTX 3000 series card. The CPU is genuinely nice for both gaming and thread heavy tasks and with sizable storage and ample fast RAM it is otherwise a very nice system indeed.

CPU: Intel Core i7 10700KF, **Cooler:** CoolerMaster MasterLiquid ML240R, **Motherboard:** Intel Z490, **Graphics:** Nvidia GeForce RTX2080 Ti 11GB, **Memory:** 32GB 3600MHz DDR4 RGB, **Storage:** 1TB M.2 NVMe SSD, 2TB HDD, **Power Supply:** 750W, **Case:** NZXT H710 with CoolerMaster MF120 Halo ARGB Case Fans



\$2,099 | tinyurl.com/y5n3mmr2

Scorptec Guardian RTX 2060 Super

Aimed squarely at the sweet spot price point this rig hits all the right notes without going overboard.

Six fast CPU cores paired with a solid performing GPU will have you gaming on 1080p high refresh rate monitors or 1440p too with ease.

Sixteen gigabytes of RAM is perfect, and even though it's not the fastest RAM in the world it's not that big of a deal for Intel CPU's so not much performance is being missed. An average sized SSD will allow you to install several big gaming titles comfortably, though the Intel 660P is quite long in the tooth now at about two years old since launch, but for gaming and general usage you won't notice any differences.

CPU: Intel Core i5 10500, **Cooler:** OEM, **Motherboard:** MSI MAG B460 Tomahawk, **Graphics:** MSI Aero GeForce RTX 2060 Super 8GB, **Memory:** Corsair Vengeance LPX 16GB 2666MHz DDR4, **Storage:** Intel 660P 512GB M.2 SSD, Seagate BarraCuda 2TB HDD, **Power Supply:** SilverStone Strider 650W, **Case:** BitFenix Enso Mesh TG White

\$3,499 | tinyurl.com/yyz94p5a

Mwave Respawn Ninja Creator & Gaming PC

Costing \$1,400 more than this month's Scorptec system, this system gets a slightly faster graphics card in the RX 5700 XT, giving it better than RTX 2070 levels of performance.

The other major boost to specifications is the R9 3900X CPU, giving it double the core and thread count, making this system quite the work horse for those with high demands. Matched with faster memory that is double the capacity, any highly threaded task will have ample compute to throw at it. Strangely, for a "creative" focused build the storage capacities are honestly a little underwhelming with just a 500GB SSD and 1TB HDD. Those using this amount of compute power will typically need large amounts of storage to match.

CPU: AMD Ryzen 9 3900X, **Cooler:** OEM, **Motherboard:** MSI MEG X570 UNIFY, **Graphics:** MSI Radeon RX 5700 XT MECH OC 8GB, **Memory:** XPG Spectrix D60G 32GB RGB DDR4 3200MHz, **Storage:** Samsung 500GB NVMe SSD, Samsung 1TB 2.5" SSD, **Power Supply:** Unknown, **Case:** MSI MPG SEKIRA 500G



PC BUILDER

Budget

Spending wisely.

SATA SSD storage has never been cheaper. TeamGroup has further reduced the price of its GX1 2.5-inch drive, and we couldn't be happier about it: 120GB of SSD storage for under 35 dollars? A few years ago, that would've been impossible to find. Both budget builds have stuck with their drives this month, as the HDD kept its price and the SSD was cheaper. We've made changes elsewhere, though: A good deal on MSI's RX 5600 XT GPU saw us making the switch from Asrock's Challenger D model for our AMD machine. Overall, we've made a modest saving on the AMD system.

The Intel build is a slightly different story. Our CPU fell in price by almost \$70. The EVGA GPU we used last month is no longer on sale, so we've gone back to a twin-fan model – Asus's TUF Gaming factory-overclocked version – at the baseline 1660 Super price of \$339. While the single-fan EVGA Super Black model was adequate, there's no reason to go down to a single fan unless it's significantly better value or you're building inside a super-compact case.

Thankfully, a fresh new motherboard and RAM for the Intel system, saved us enough money to keep the price at exactly \$1,300. The AMD system

is now slightly cheaper, but allowing for general component price deviation, these two systems may as well share a price tag right now. Performance-wise, we won't see a huge amount of difference either. The RX 5600 XT slightly outperforms the GTX 1660 Super,

but only by a small margin: Both excel at 1080p and are moderately capable at higher resolutions. On the other hand, the Ryzen chip falls just short of the i5-9600K in performance terms, but is cheaper and draws less power.

“A fresh new motherboard and RAM for the Intel system, saved us enough money to keep the price at exactly \$1,300. The AMD system is now slightly cheaper, but allowing for general component price deviation, these two systems may as well share a price tag right now.”



AMD INGREDIENTS

PART		PRICE
CASE	BITFENIX NOVA TG	\$120
PSU	450W EVGA 450 BR	\$69
M/BOARD	ASROCK B550 PHANTOM GAMING 4	\$189
CPU	AMD RYZEN 5 3600	\$309
GPU	MSI RADEON RX 5600 XT 6GB NEW	\$477
RAM	16GB (2 X 8GB) TEAM T-FORCE VULCAN Z @ 3,000MHZ	\$109
SSD	120GB TEAMGROUP GX1 2.5" SATA III	\$34
HDD	1TB SEAGATE BARRACUDA HDD	\$70
OS	UBUNTU DESKTOP LINUX 18.04 LTS 64-BIT	\$0
PRICE:		\$1,377

INTEL INGREDIENTS

PART		PRICE
CASE	BITFENIX NOVA TG	\$120
PSU	450W EVGA 450 BR	\$69
M/BOARD	MSI PRO Z390-A NEW	\$239
CPU	INTEL CORE I5-9600K	\$299
GPU	ASUS TUF GAMING GEFORCE GTX 1660 SUPER 6GB NEW	\$339
RAM	16GB (2 X 8GB) GEIL EVO SPEAR @ 2,400MHZ NEW	\$55
SSD	120GB TEAMGROUP GX1 2.5" SATA III	\$109
HDD	1TB SEAGATE BARRACUDA HDD	\$70
OS	UBUNTU DESKTOP LINUX 18.04 LTS 64-BIT	\$0
PRICE:		\$1,300

“We upgraded the Intel motherboard, sticking with MSI but opting for the slightly higher-end Z390 Gaming Plus model. The AMD build didn’t warrant a new motherboard, but we did see an appreciated fall of \$50 on the price of MSI’s Radeon RX 5700.”

PC BUILDER

Mid-range

Right on the sweet spot.

Right off the bat, we saved \$40 on both systems thanks to a discount on the Meshify C case from Fractal Design. We’d hoped to refresh all the cases earlier this year (and shoot them in our studio), but the specter of COVID-19 hanging over us precluded that from happening. It still will, though – hopefully soon!

PSU prices are on the move, and this month we’ve opted to give both mid-range systems the same power supply: The reliable Corsair CX650, which should provide more than enough juice. We upgraded the Intel motherboard, sticking with MSI but opting for the slightly higher-end Z390 Gaming Plus

model. The AMD build didn’t warrant a new motherboard, but we did see an appreciated fall of \$50 on the price of MSI’s Radeon RX 5700. There are a few cheaper options available, sure, but we’re not downgrading to a single-fan GPU for anything less than a \$50 saving.

Really, there wasn’t much else to change in the AMD build this month. A few handy price drops here and there were a welcome sight, and the Corsair Force MP600 SSD remains the best-priced 500GB drive that supports PCIe 4.0 transfer speeds.

We had more work to do on the Intel system; saving ourselves a few dollars by swapping to a different dual-fan air cooler was a start, but

we were curious about upgrading the SSD too. Upon inspection, however, we found that the 500GB WD Black SN750 benefitted from an even bigger discount, now costing just \$159 for half a terabyte of speedy M.2 storage. For reference, that’s the version of the SN750 that comes without a heatsink – you may want to spring for the more expensive heatsink-included version to reduce heat buildup, since the Z390 motherboard we’re using doesn’t have its own thermal solution for M.2 drives.

On top of that we saw price drops across several components which led to an impressive \$345 saving over last month for the Intel system and \$185 for our AMD PC.



AMD INGREDIENTS

PART		PRICE
CASE	FRACTAL DESIGN MESHIFY C	\$189
PSU	650W CORSAIR CX650 NEW	\$139
M/BOARD	ASUS TUF GAMING X570-PLUS	\$346
CPU	RYZEN 7 3700X	\$525
COOLER	NOCTUA NH-U12S	\$129
GPU	MSI RADEON RX 5700 8GB	\$599
RAM	16GB (2 X 8GB) CORSAIR VENGEANCE LPX @ 3,200MHZ	\$101
SSD	500GB CORSAIR FORCE MP600	\$199
HDD	1TB SEAGATE BARRACUDA HDD	\$70
OS	WINDOWS 10 HOME 64-BIT OEM	\$140
PRICE:		\$2,400

INTEL INGREDIENTS

PART		PRICE
CASE	FRACTAL DESIGN MESHIFY C	\$149
PSU	650W CORSAIR CX650 NEW	\$139
M/BOARD	MSI MPG Z390 GAMING PLUS NEW	\$199
CPU	INTEL CORE I7-9700F	\$425
COOLER	COOLER MASTER HYPER 212X NEW	\$59
GPU	GIGABYTE GEFORCE RTX 2060 OC 6GB	\$579
RAM	16GB (2 X 8GB) G.SKILL RIPJAWS V SERIES @ 2,400MHZ	\$109
SSD	500GB WESTERN DIGITAL WD BLACK SN750 M.2 PCIE SSD	\$159
HDD	1TB SEAGATE BARRACUDA HDD	\$70
OS	WINDOWS 10 HOME 64-BIT OEM	\$140
PRICE:		\$2,029

PC BUILDER

Turbo

This one goes to 11.

We still couldn't really justify an upgrade to a 3rd-generation Threadripper chip in our AMD build. We know this is a "Turbo" system, but the 16-core Ryzen 9 3950X is still a beast, and far cheaper. It also meant we could stick with the excellent X570 chipset for our motherboard, and this month we're rocking the Prime X570-Pro from Asus. We toyed with swapping out the RAM and SSD in our AMD build, but both components have seen small price drops since last issue, so we decided to leave them be.

High-end graphics cards are nose-diving in price since Nvidia announced its surprisingly cheap 3070, 3080 and somewhat affordable 3090. RTX 2080 Super cards are bargain buys right now, so if you see one up for a good price, snap it up fast – if you don't have your eye on a 30-series card, that is... EVGA's KO Gaming model was the only one still available at a reasonable price point when we wrote this, so we've unified these two machines and given the Intel system that GPU as well. It's \$200 cheaper than this time last month, too, reflecting the massive discounting happening in that segment right now following the 30-series pricing.

The Intel build also received a boost in the form of a bigger AIO

cooler, the Cooler Master MasterLiquid ML360R ARGB, exchanging two 140mm fans for three 120mm ones instead. We're duplicating the Patriot Viper SSD in the AMD build here because it's great value and a good performer. Both of these PCs dropped in price this issue, but the Intel Turbo build has increased its lead over the

AMD system in terms of value. The AMD system does benefit from PCIe 4.0 and more cores, though, so we'd say it's a fair fight.

Overall the savings this month were turbo-charged by the fall in Nvidia 20-series prices, yielding us unusually hefty savings of \$283 for the AMD PC, and a huge \$393 for the Intel build. Not bad!



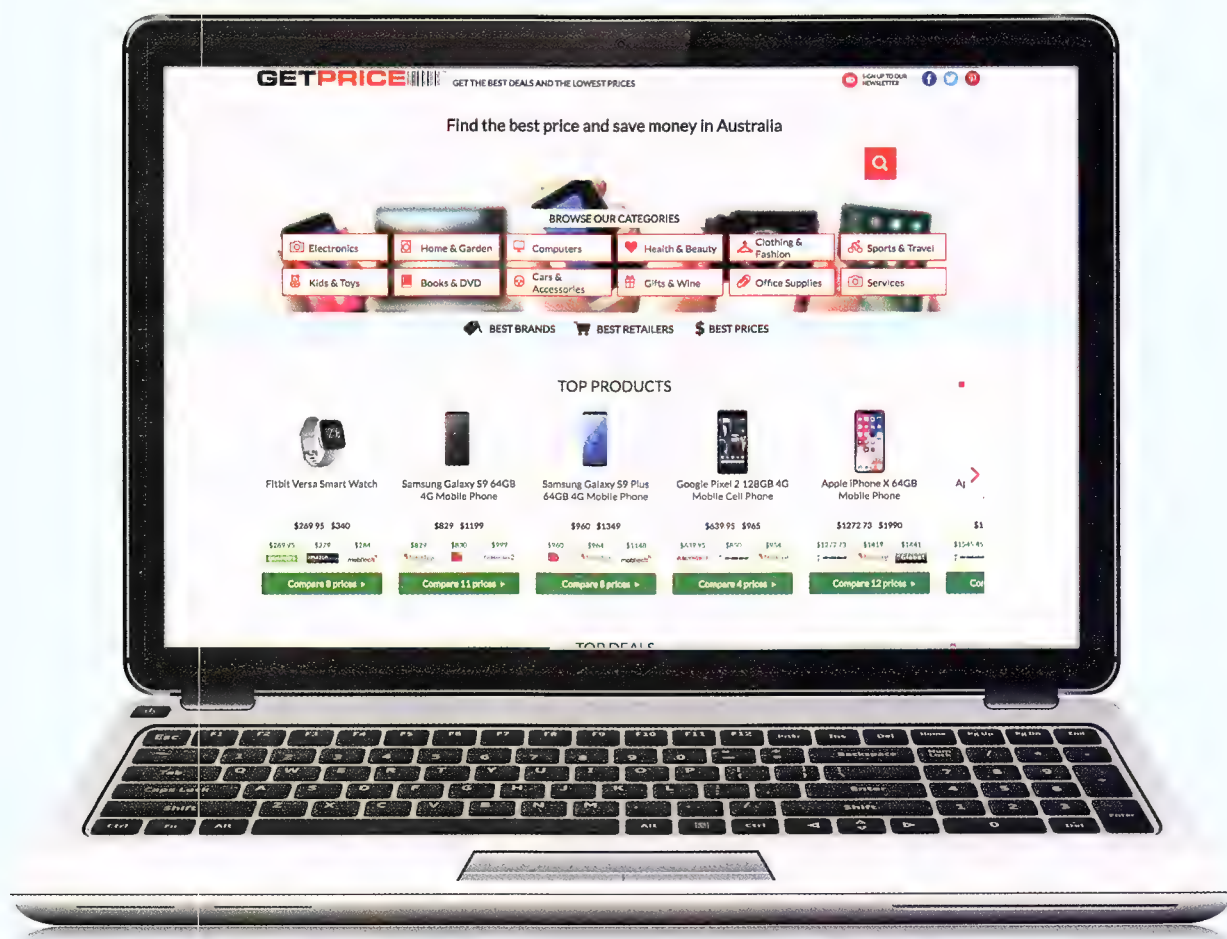
“High-end graphics cards are nose-diving in price since Nvidia announced its surprisingly cheap 3070, 3080 and somewhat affordable 3090. RTX 2080 Super cards are bargain buys right now, so if you see one up for a good price, snap it up fast.”

AMD INGREDIENTS

PART		PRICE
CASE	NZXT H710I	\$309
PSU	850W CORSAIR RM850X WHITE NEW	\$226
MOBO	ASUS PRIME X570-PRO NEW	\$379
CPU	AMD RYZEN 9 3950X	\$1,219
COOLER	CORSAIR ICUE H115I RGB PRO XT 280MM	\$219
GPU	EVGA GEFORCE RTX 2080 SUPER KO GAMING 8GB	\$1,099
RAM	32GB (2 X 16GB) G.SKILL TRIDENTZ NEO @ 3600MHZ	\$259
SSD	1TB PATRIOT VIPER GAMING VP4100 M.2 PCIe SSD	\$319
HDD	6TB SEAGATE BARRACUDA HDD	\$269
OS	WINDOWS 10 HOME 64-BIT OEM	\$140
PRICE:		\$4,438

INTEL INGREDIENTS

PART		PRICE
CASE	NZXT H710I	\$309
PSU	850W CORSAIR RM850X WHITE NEW	\$226
MOBO	ASUS ROG STRIX Z490-E GAMING	\$499
CPU	INTEL CORE I9-10900K	\$999
COOLER	COOLER MASTER MASTERLIQUID ML360R ARGB 360MM NEW	\$189
GPU	EVGA GEFORCE RTX 2080 SUPER KO GAMING 8GB NEW	\$1,099
RAM	32GB (2 X 16GB) CORSAIR VENGEANCE RGB PRO @ 2,666MHZ	\$199
SSD	1TB PATRIOT VIPER GAMING VP4100 M.2 PCIe SSD	\$319
HDD	6TB SEAGATE BARRACUDA HDD	\$269
OS	WINDOWS 10 HOME 64-BIT OEM	\$140
PRICE:		\$4,248



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PC MASTERCLASS

A PC PROJECT BUILD WITH A PURPOSE

BUILD IT

Sub-\$900 budget build

When it's not about gaming, just what can you get on a budget?

At APC we do sometimes lean a bit too heavily on the gaming angle. That's no doubt in part because a large majority of the team here enjoy that pastime, and the industry advances quite aggressively because of it too. So we assume you lovely folks are fond of gaming, but as old pappa Storey used to say, "Never assume anything, else you're an idiot." He may have been a bit unorthodox, and lacked a smidge of accuracy with his clichés, but he was also right when he said it.

So this issue we've decided to set ourselves a challenge – strip everything down and get back to the basics of what makes a PC a PC. We're not building a gaming rig, an expensive high-end dream machine, or a workhorse rendering station, but instead a work PC, an everyday PC: A system that performs well, looks good, is affordable, and can handle those daily tasks the majority of us spend most of our time doing.

There's one caveat: We wanted to do this without compromising on quality, or setting ourselves some arbitrary cost number to hit. It's not about hitting a specific budget – although of course we have to advertise it like that – or hitting x frames in y benchmark. It's about building a system that's right to use on a daily basis. And integrated graphics have come such a long way, you could do a bit of casual gaming on the side anyway.

So how did we find it? Well, it's been quite the ride, and surprising as to what you can get for a fairly minimal outlay. OK, we're not including peripherals or a monitor here, and this is costed just to the base system itself. But for \$859 we nabbed a quad-core, eight-thread processor, 16GB of high-spec DDR4, and a 1TB M.2 PCIe SSD, rated for 1800 MB/s sequential read and writes. How did we do it? Well let's dive in.



ZAK STOREY
APC
Senior Editor

PART		STREET PRICE
CPU	AMD RYZEN 5 3400G	\$239
MOBO	ASROCK B450M-HDV MICRO ATX	\$99
MEMORY	16GB (2X 8GB) CORSAIR VENGEANCE LPX @ 3200 MHZ	\$115
STORAGE 1	1TB INTEL 660P M.2 PCIe 3.0 SSD	\$188
PSU	600W EVGA 100-W1 -0600-K1 80+	\$119
CASE	PHANTEKS P300 ATX MID-TOWER CASE	\$99
TOTAL		\$859

"It's not about hitting a specific budget – although of course we have to advertise it like that – or hitting x frames in y benchmark. It's about building a system that's right to use on a daily basis."



The Hardware

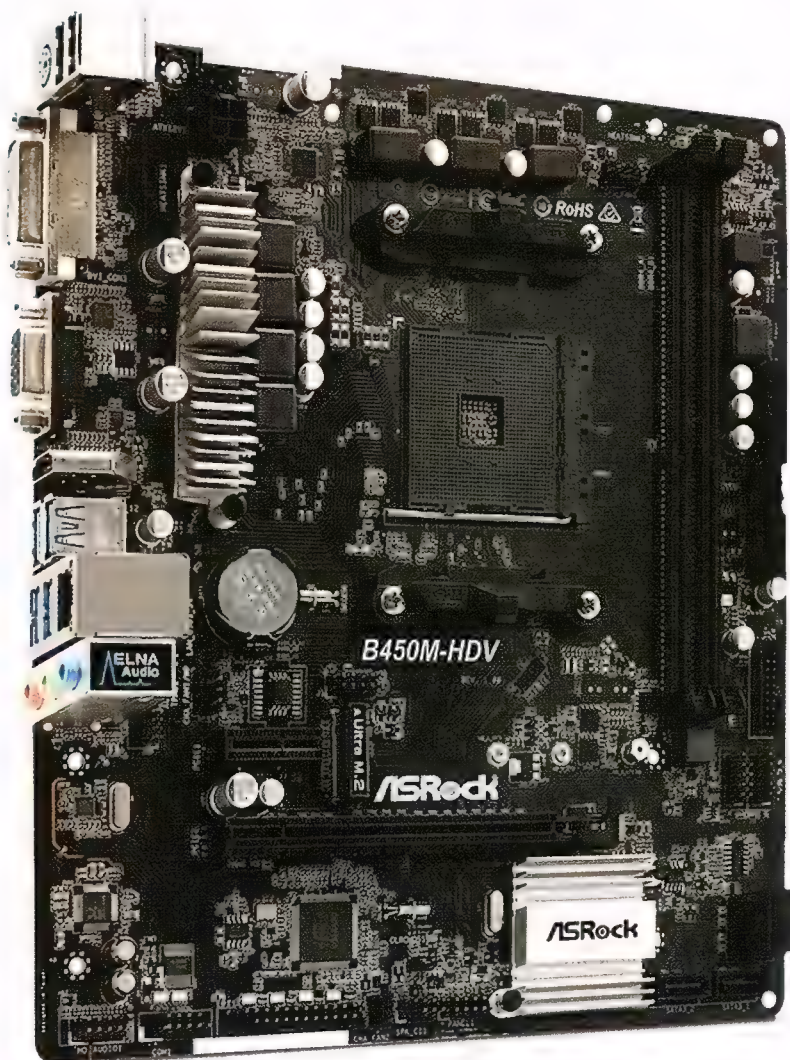


Memory

16GB (2x8GB) Corsair Vengeance LPX @ 3200MHz

\$115

Memory prices may have been skyrocketing a few years back, but now it's a whole other ballpark. 16GB of high-speed memory for just \$115? Count us in. Ryzen's infinity fabric interconnect (the stuff that connects the core complexes in the die) runs at the same speed as the memory. Ryzen 3rd gen typically disconnects after 3600MHz, but as our Ryzen 5 3400G is running on the old 2nd-gen architecture, it's not quite as quick, and only sees benefits up to 3200MHz. For our Intel solution, you'll have to opt for slower memory, as the Asrock B365M-HDV is only rated to support up to 2666 MHz.



Motherboard

Asrock B450M -HDV

\$99

With support for up to two sticks of DDR4 at 3200MHz, an M.2 slot for our PCIe drive of choice, and a full-size PCIe 3.0 slot if we decide to upgrade in the future, this Asrock B450M-HDV is absolutely perfect for our build, especially for \$99. That said, it is a bit light on the rear I/O side of things. You get four USB 3.0 ports, two USB 2.0 ports, Gigabit Ethernet, three-channel audio, HDMI, DVI-I and VGA out, and a PS/2 combo port as well.

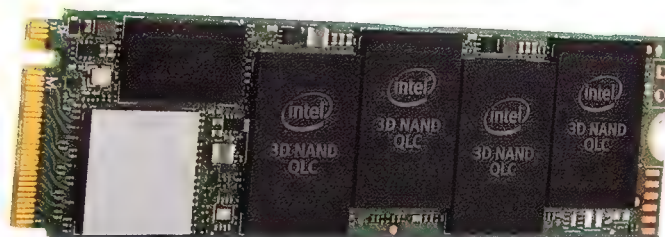
For the intel enthusiasts, Asrock's B365M-HDV is a perfect pairing for the Core i3-8100 above. It's almost identical to the B450M featured here, but it only supports memory up to 2666 MHz.

CPU AMD Ryzen 5 3400G

\$239

Yes we've gone with AMD for this build, purely because its Ryzen APUs are fairly competitive when it comes to both cost and performance. With four cores and eight threads lined up over two core complexes, it's a fantastic chip for those looking to build something that'll work on a budget. Alternatively, if your heart's set on Team Blue, you could opt for an Intel Core i3-8300 for about \$290, but you'd lose access to that hyper-threading, meaning you'd only have four cores, and you'd have to put up with slightly inferior integrated graphics performance compared to Intel's 9th-series processors.





Storage 1

1TB Intel 660P M.2 PCIe 3.0 SSD

\$188

Now first let's start by saying this isn't the best PCIe 3.0 drive in the world. It's based off of QLC NAND flash tech, which is a heck of a lot less impressive than the alternatives. It's got lower overall endurance and slower performance than the likes of SLC, MLC, or TLC flash. That said, there's no denying just how much bang for the buck you get. We're talking sequential read and writes up to 1800 MB/s, making it a fairly proficient budget drive for those not looking to render massive video files on a daily basis. Combine that with a fairly helpful 1.6M hours mean time between failures, and it's perfect for everyday office use.

Case

Phanteks Eclipse P300 TG

\$99

Another budget-busting part is this fantastically well-rounded chassis from Phanteks. For \$99, you get a small mid-tower chassis equipped with tempered glass, a tiny smidge of RGB, a full-size PSU cover, and support for up to a 280mm AIO in the front if you so desire. There's even a suitable amount of cable management around the back too, and it's available in multiple colour schemes. The only downside? It comes with a single 120mm fan, but that's not the end of the world. Flip it to act as an intake, and you're good to go. OK, let's stop gushing about this case and move on.



Power Supply

600W EVGA 100-W1-0600-K1 80+

\$119

One thing you can't go wrong with is an EVGA power supply. The company has a legacy for top-quality warranty and customer support, so if things do go wrong later down the line, you can rest assured it's got your back. This PSU is a non-modular, 80+ rated power supply and should be ideal for our aspirations here. We're expecting this PC to draw around 145W from the wall under load, meaning we've got a good 75 percent additional capacity on top of what's available. Heck, even if you added an Nvidia GeForce RTX 2070 Super you'd still only be looking at 361W under load—although we recommend you don't do that, as the Ryzen 5 3400G only has x8 PCIe 3.0 lanes for graphics cards.

BUILD IT

Building on a budget

A step-by-step guide to putting
the perfect \$900 budget
PC together

Length of time: 1-2 hours

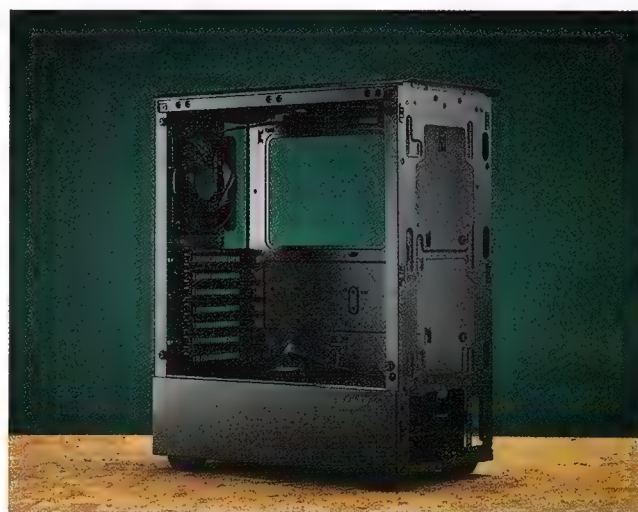
Level of difficulty: Easy



01 CASE UNBOXING

So here we have it, our Phanteks Eclipse P300. What Phanteks has achieved here is impressive. We loved it back in 2018, and it's still one of the better budget cases out there. For the low price you still get support for up to a 280mm AIO cooler in the front, a tempered-glass panel, full-size PSU cover, ample cable management, a fleck of RGB, and fairly good airflow too. It's not perfect, but at this price, it kind of is.

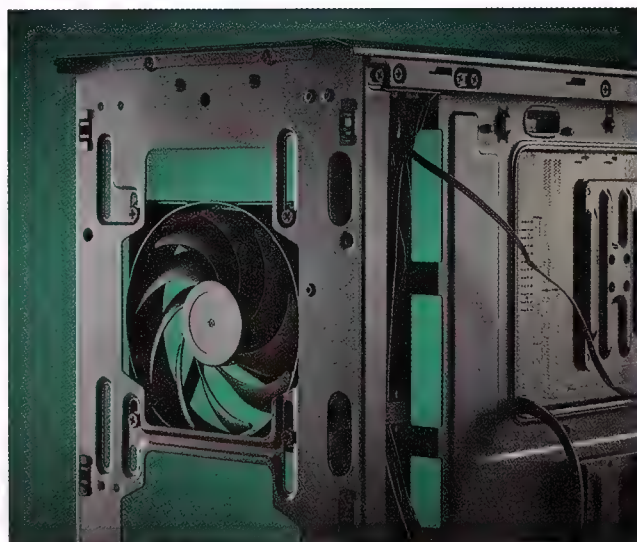
Where does it fall down? Well some of the materials used on the inside are prone to fingerprints, it can be a bit tight to work in, and of course it only comes with a single 120mm fan as standard - but then again, it's \$99.



02 CHASSIS STRIPDOWN

This is a piece of advice we continually tout when it comes to building PCs, and with good reason, as it makes things so much easier. Strip down your case - the first thing you should always do is remove as much of the chassis as possible so you end up with a hollow skeleton. Not only does it mean you won't damage the panels, but it's also far easier to get your hands into all those tight nooks and crannies.

It's also a good opportunity to shave weight and improve airflow by removing things such as the hard drive cages and caddies, and unnecessary disk bays and things like that. Just remember where you put them if you decide you need a 3.5-inch drive later down the line.



03 MOTHERBOARD INSTALL

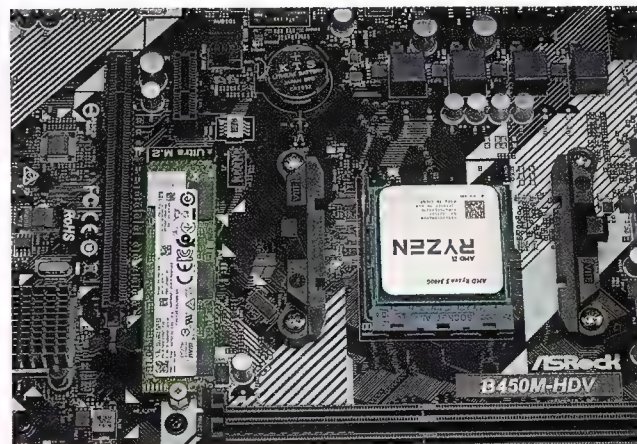
We typically don't recommend you do this for most builds, as it's far easier to install your main components (CPU, RAM, SSDs) outside of the case first. However, in this build we're making an exception, as the system itself is fairly simple to put together and there's no additional AIO backplate or frustrating heatsinks to deal with for the M.2 drive.

One big difference between this system and the builds we usually produce is that this has a separate I/O shield. Always remember to install this first. Then it's a case of placing the motherboard in, making sure you don't trap that stock fan cable, and securing it down with the included motherboard screws that you'll find in the case accessory box.

04 FAN RELOCATION

This may seem like a trivial thing, but we've opted to move the fan to the front of the chassis instead of its default location in the rear. We're big supporters of positive pressure systems, and although there's only one included fan, having it act as an intake to draw cool air across the CPU heatsink is going to do this build a world of good.

That said, it's our biggest caveat for this case - not enough fans. If you've got a spare 120mm fan kicking around, throwing it in the front as well will help a lot. Positive pressure in a case ensures that cool air is drawn in through dust filters, and then hot air is pushed out through unfiltered areas. That helps reduce dust build-up inside your system.



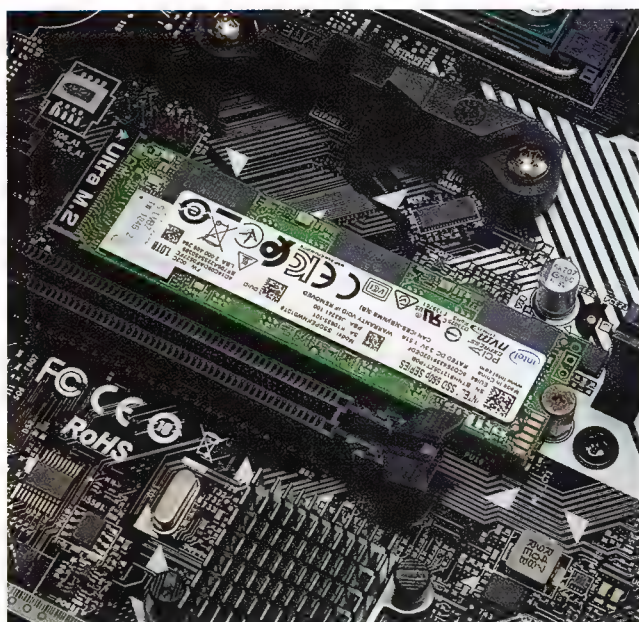
05 AM4 INSTALLATION

Now we can take the opportunity to install our AMD Ryzen 5 3400G processor. To do this, simply lift up the retention arm on the AM4 socket, take your processor, identify the gold triangle located on the bottom-left side of the processor, line it up with the triangle on the socket, and carefully lower it down, lining the pins up with the holes in the socket itself. Once placed in, give it a tiny wiggle with your thumb to make sure it's secure, then lower the retention arm back down and into position to lock it in place.

06 FRONT PANEL CONNECTORS

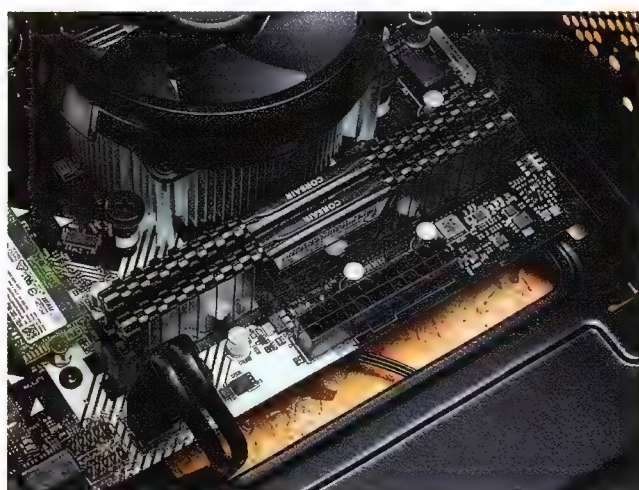
It's time to get the front panel headers in. The Eclipse P30 doesn't have the best front panel I/O, but for cabling all you've got to worry about is an HD audio passthrough, a USB 3.0 cable, a power button cable, and an HDD LED cable.

Installing those last two can be a bit tricky. The HDD LED cable needs to be plugged in a certain way so that the positive and negative terminals are in the correct position. However, for the power it doesn't matter, as its job is to bridge the two pins. Our Asrock B450M-HDV has the pins labelled on the board itself, but if yours doesn't, check your motherboard's manual. For the HD audio passthrough, that's always located on the bottom left-hand side of the motherboard, and for the USB 3.0 port, you'll find it has a notch in the cable, so you can install it correctly. We're also plugging in our front 120mm fan on the bottom of the board into a chassis fan header. Again there's a notch in the cable.



07 INSTALLING INTEL'S M.2 PCIe SSD

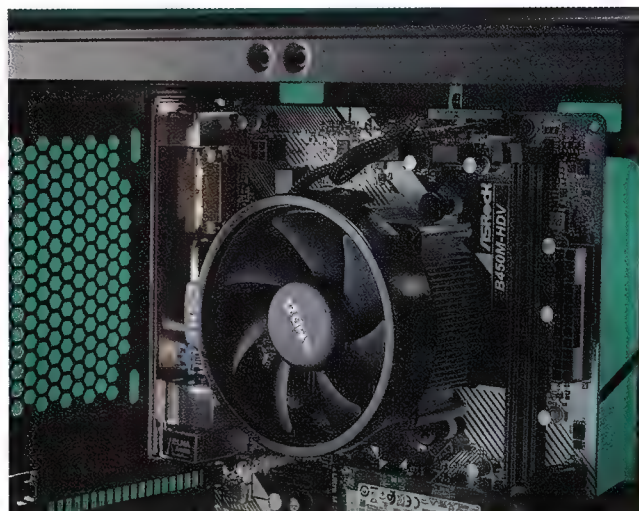
Installing an M.2 SSD is one of the easier things you can do with a system build. Simply use a small screwdriver to remove the screw at the end of the M.2 socket itself. Slot the M.2 drive into place (making note of the location of the notch on the drive), carefully push the drive down on top of the pin at the other end, and resecure it with the screw you removed earlier. And you're done – no finicky SATA power cables, cable routing, or drive mounting. Nothing.



09 DDR4 ON BOARD

Our memory of choice here is this 16GB dual-channel Corsair Vengeance DDR4. The Vengeance line is a bit more budget-oriented, but this kit still packs in some impressive timings and an impeccable frequency. Ryzen's Infinity Fabric interconnect runs at the same frequency that your memory operates at. It's to do with the memory controller. Because the fabric interconnects with the core complexes, having it operate at a higher frequency means cores across those complexes can transfer data and process requests faster.

With 1st and 2nd-gen Ryzen, you'll see benefits up to 3200MHz. With 3rd-gen Ryzen, that goes up to 3,733MHz, after which point the memory controller and the Infinity Fabric disconnect, and you'll no longer see performance gains.



08 HEATSINK IN PLACE

With the M.2 in, it's time to install the included cooler. AMD's Wraith coolers are seriously impressive units and come with a fairly foolproof mounting system. Remove the plastic cover that protects the base of the cooler – this is protecting the pre-applied thermal paste already on the base of the heatsink. Then, remove the two brackets situated above and below the socket, hold onto the back plate, behind the motherboard, carefully place your heatsink on top and secure it in a diamond or diagonal pattern. Carefully secure one corner down at a time with a screwdriver, making sure you don't go past the thread itself.

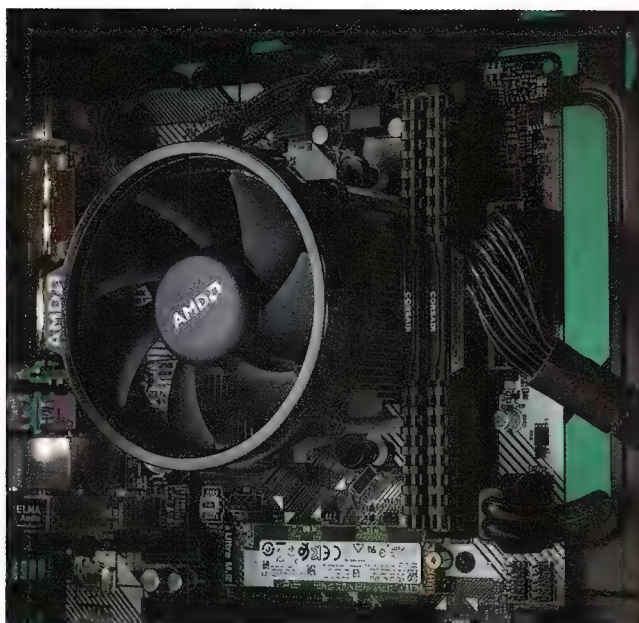
Now tidy up that PWM fan cable. Tie it into a little loop, then plug it into the CPU fan header at the top of the motherboard.



10 PSU ORIENTATION

When it comes to installing the power supply there's not a whole lot to it. Simply slot it in the back of the case, line it up, and secure it down with the four screws included in your case's accessory box. One thing worth noting is that you will have to make sure the fan is facing down toward the bottom grill/filtered area, as the PSU cover itself doesn't have any ventilation cutouts facing towards the motherboard.

That's great for power-supply longevity, as you're not dumping excess hot air into your componentry there, but the downside is that when you have so few fans in a case like this, it would be good to use it as an additional exhaust.



11 24-PIN CABLING

We're getting to the final stages of the build now, and things are starting to finally wrap up. All we have left to do is install the power supply cables. That's the 24-pin motherboard ATX power, and (in this scenario) a single four-pin EPS power for the CPU. Our B450 motherboard doesn't require too much juice to run. Fortunately the Phanteks Eclipse P300 comes with ample cable management, so it's not too difficult to run them up and around.



13 BUILD COMPLETE

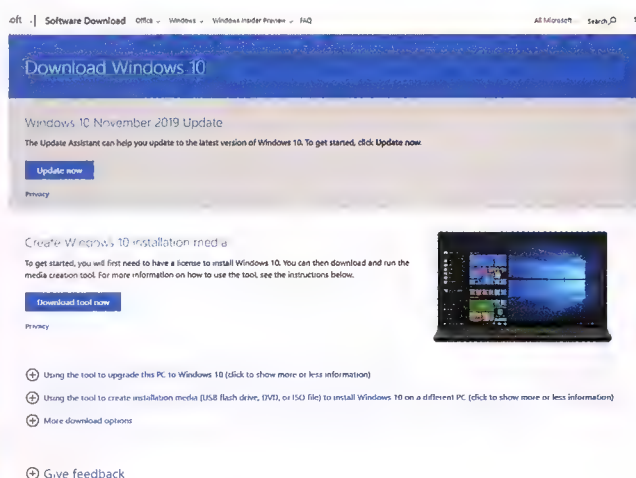
And there you have it, one complete system ready to go. For just under \$900 you get access to a 1TB PCIe 3.0 SSD, 16GB of DDR4 3200 MHz dual-channel memory, and a hefty four-core, eight-thread processor. There's a fleck of RGB thrown in too (controlled via a button on the top of the I/O).

This is a really nice build for those not looking at that gaming angle. For office work and day-to-day use, it's going to be quick and to the point. The only major difference is the lack of a dedicated GPU. The Eclipse P300 is a fantastic case, and the fact that you can pick one of these up for just shy of \$100 at the time of writing is nothing short of incredible. It's clean, has plenty of modern build features included, and it's just a pleasure to build in.



12 REAR CABLE MANAGEMENT

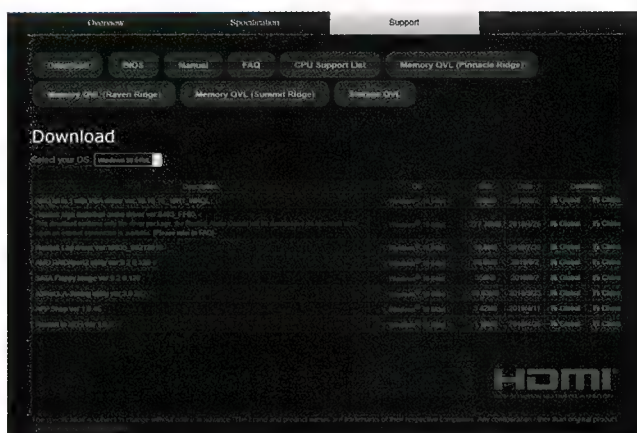
And here's a shot of the rear. You can see we've tucked the majority of our excess cables out of sight down below where the hard drive caddy is, and then just routed the main power cables in a direct line to where they need to be. There's nothing fancy going on here, and we've still got space to add some 2.5-inch or 3.5-inch drives if we want to, after the fact.



14 BOOTABLE WINDOWS

Now it's time to get Windows installed. To do this, head to Google and search for "Windows Media Tool" on a separate system or laptop. Click the top result: "Download Windows 10 Disc Image (ISOFile) - Microsoft", which will take you to the official Microsoft website. You'll see a sub-heading called "Create Windows 10 installation media." Click "Download tool now."

Once that's downloaded, run the program, and it'll identify which version of Windows you're using. Plug in an 8GB USB stick (preferably USB 3.0), accept the terms and conditions, then select "Create installation media (USB flash drive...)" and hit "Next." In the next screen select your options. Making sure that your architecture is 64-bit, hit "Next" again, then choose USB flash drive, then hit next again, select the drive you've plugged in, and Windows will begin creating your bootable Windows install USB drive.



15 DRIVERS & BIOS

Next, pick up some key files for your system. On your other device, head to your motherboard's product page. Click "Support," and find your drivers. It's always better to get the brand-new ones from the website, and not rely on those found on the discs enclosed with the motherboard. Also, although some motherboards' Ethernet ports work without a driver download, some don't, so it's handy to have these.

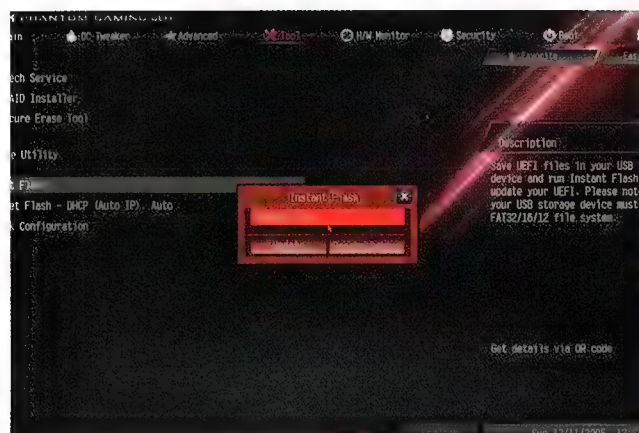
Create a new folder on your USB stick and label it "BIOS," and another one called "Drivers." Make sure you download the AMD all-in-one driver/AM4 Chipset, your network driver, your audio driver, and then place them in "Drivers." As an aside, if your build has a dedicated GPU, you can also pick up your GPU drivers. After that, get the latest version of your BIOS – there should be a "BIOS" tab on the support page. Grab the file, then move it to your "BIOS" folder on the USB stick, and extract it on the drive before you go to your build.



17 INSTALLING WINDOWS

Next, head to the "Boot" section of your BIOS, and reorder or boot from your USB stick – it should be labelled as "Windows 10 UEFI USB," or something similar. Move it to first in the queue, and hit F10 to save and exit. Your system will restart and then begin to run you through the installation process. Here select what language and keyboard layout you want to use, then after install it'll run you through which features you want to enable (we usually disable all ad tracking, Cortana, and full diagnostic options on every install).

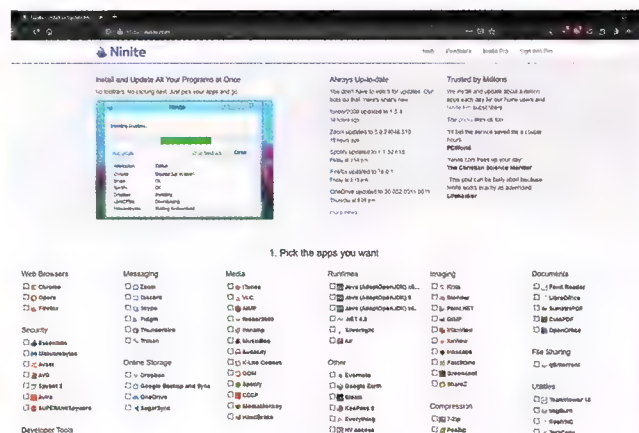
If you've got an Ethernet cable plugged in and your port is working, it will also ask you to login to your Microsoft account or create one before letting you proceed. If you don't want to do that, just remove the Ethernet cable prior to the installation of Windows 10, and it'll let you create a local account and password. You can activate it or login later on the desktop if you want to.



16 UPDATING BIOS

This part can be scary. If you do mess it up, it's very hard to come back from without warranting the board, and not all manufacturers accept liability for that (something Asrock states on its website). But as long as you don't suffer a major power outage or turn off the system, it's completely safe.

Plug the USB stick with the BIOS and Windows Installer into the back of your new system, and power it up. Mash the Delete key on startup to get into the BIOS. This part will vary depending on motherboard manufacturer, but you're looking for the same area and the same feature. In Asrock's case, select "Instant Flash" under the "Tool" section at the top of the BIOS page. Scan for your devices, find your USB stick, then the "BIOS" folder, and select the BIOS file you downloaded earlier. Hit "Update" and let the motherboard do its thing. It'll restart once or twice. Eventually you'll end up back in the BIOS screen with a freshly updated BIOS.



18 THE POWER OF NINITE!

Using Ninite has become almost a ritual of ours whenever configuring and setting up a new system. Once you're on the desktop and your drivers are installed, use an internet browser to reach <https://ninite.com>. From there you can download the latest versions of a bevy of programs, including web browsers, security essentials, messaging applications, media centers, imaging tools – you name it.

Select what programs you want to download and install, and then hit the "Get Your Ninite" button at the bottom of the page. Run the installer, and Ninite will download and install all of the programs you requested, but without having to search the internet for them or being attacked by unwanted adware in the process.



Budget-busting expectations

And there you have it, one complete budget build for \$900. So what was it like to build?

Well honestly, not that difficult. A lot of budget builds are actually far less complex than you'd think. Realistically, there's a total of six separate parts that need installing in the case itself, and all of them are fairly plug-and-play. There's nothing very difficult, and it's a perfect opportunity for a first-time builder to stretch their legs into this hobby of ours.

Get down the line a bit, and fancy investing in a dedicated graphics card? You could easily throw in an AMD Radeon RX 570 or Nvidia GeForce GTX 1650 Super, both of which you can get for around \$200 at this point. It's worth noting that the Ryzen 5 3400G at the heart of this build (and in fact, all of AMD's APU

processors) only comes with 8 PCIe 3.0 lane dedicated graphics, as opposed to the 16 you'll find on its non-integrated cousins. This is where Intel edges out a bit. Our recommendation for an Intel alternative is the Intel Core i3-8300. That's a quad-core part, minus the hyper-threading, but it comes with integrated graphics and 16 PCIe 3.0 lanes as standard for the GPU, which oddly (given the recent announcement of AMD only supporting Ryzen 3rd gen on its X570 series motherboards going forward), makes it the more attractive long-term choice.

As for performance, our budget-busting box did fairly well. Boot times were quick and sharp thanks to that M.2 PCIe SSD,

01

One of the nicer touches to the Asrock B450M-HDV board is the fact that the M.2 slot is situated above the PCIe 3.0 slot, meaning it won't get hot from a graphics card sitting directly above it.

02

If you do intend to go with a dedicated GPU later on, bear in mind performance will be worse, since AMD's APU series processors only support 8 PCIe 3.0 graphics lanes, as opposed to the 16 you'll find elsewhere.

03

The first thing we'd do if we were to run this long term would be to install some more fans. Investing in two premium 120mm fans for the front and then moving that included one back to the rear would work a treat.

04

If you dropped down to 8GB and a smaller SSD with Intel you could likely pick up an AMD Radeon RX 570 to act as a dedicated GPU if you wanted to.

although on the big file transfers the QLC NAND struggled a bit – it was pretty good with loading programs and transferring multiple sequential stuff, but with larger file transfers it struggled after a few minutes.

For everyday use it easily meets the mark. We also tested its graphical prowess, and at 1080p on Ultra it was capable of handling AAA titles, although not by any large measure. So if you're looking for some casual gaming on the side, the AMD Ryzen 5 3400G is king.

Ultimately, it's a sweet little box at a nice price, and more than ideal for anyone that's just looking for a high-spec PC to build today for a low outlay. ■

APC LABS BENCHMARKS

Indicates best result

	Cinebench R15 Multi	SSD 1: CrystalDisk QD1 Random 4K Read	SSD 1: CrystalDisk QD8 Sequential Write	Middle Earth: Shadow of War	Total War: Warhammer II	Assassin's Creed Odyssey (fps)	3D Mark Firestrike
	Index	MB/s	MB/s	fps	fps	fps	Index
Budget build	881	1,876	1,581	21	15	13	3,591
Zero-point	598	562	521	15	10	9	2,642

Our zero-point consists of an AMD Ryzen 3 3200G, 16GB (2x8GB) Corsair Vengeance LPX DDR4 @ 2666, and a 500GB Crucial MX500 SSD. All game tests were performed at 1080p Ultra.

HOW-TO

TOP TIPS TO TACKLE TECH TROUBLES

QUICK TIPS

APC experts solve computing problems

The APC team tackle problems across the spectrum of devices and software we use. Learn a new trick or fix you can use.

Random freeze part 2

Regarding my earlier email about random freezes, by the time you responded, the whole PC had broken down: When I power on, the fans light up, and so does the RGB, but nothing else lights up, and the ROG logo does not light up when the machine is off. It was supposed to be on all the time.

About the corrupt RAM, I have seen several blue screens with the stop codes "SYSTEM_THREAD_NOT_HANDLED" and some other memory management error. I mainly play Terraria and Geometry Dash on the PC. I could try buying a new set of RAM from a different manufacturer, or is it the mobo? Finally, to answer your earlier question, I have a 750W PSU.

RECTOR-STINGRAY

APC responds: At first glance, the blue screen errors would suggest that your RAM is the problem, but it might also point to a failing drive (or even just a drive that needs a good run-through with the Disk Check tool). The fact your PC appears to have "broken down" would point towards the RAM, processor, or motherboard, though – key components required for the PC to get as far as the POST screen. We can't give you a definitive answer as to which is the culprit, but he can show you the steps he'd follow in your position.

First, the cheapest and easiest component to test is the RAM – and the blue-screen errors would

suggest this is the best place to start. If your PC could get beyond the POST screen, we'd recommend you create a Memtest86 bootable flash drive (www.memtest86.com) on another PC, then boot from that to grill your RAM and hopefully confirm the diagnosis with test failures.

Assuming you can't even get as far as the POST, you may still have one quick diagnosis option left. If you purchased your RAM as a pair of 4GB sticks, try removing one and seeing if your PC will now boot; if it doesn't, try the other. With a bit of luck, only one stick will be corrupt, and you'll be able to boot using the working stick. If so, your solution would be simple: Replace the RAM with sticks known to be compatible with your motherboard (there's a comprehensive list at <https://bit.ly/MPCoctrAM>).

If you only have one stick of RAM, or trying the above test fails to work, you'll have to make a decision about which parts to swap out: We would probably order more RAM first in the knowledge that if it doesn't fix the problem, you could either return the RAM or keep it to boost your PC's memory later.

One final thing: Your motherboard should issue a short beep when it starts – if you've never heard this, then have you connected it to the case's system warning speaker (consult page 1-20 of your motherboard manual for details). Once connected, you should hear a series of beeps at startup – one continuous beep

followed by several short beeps:

Two indicates memory failure, three no monitor detected, four for hardware component failure, which would indicate a problem with the motherboard or processor.

If you decide to replace the board, a direct swap is the simplest option because your current Windows installation won't be affected, and you can be up and running again quickly. Hopefully, you'll still be under the manufacturer's warranty, so RMA it.

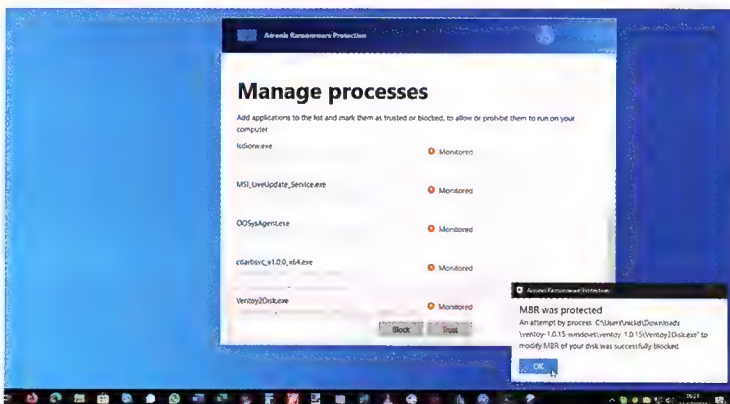
Tame default apps

I have a pet peeve against Microsoft. Seems that every update, the default apps for specific file extensions get changed to what they want and totally ignore what I want them to be. Specifically, I mean HTM, HTML, and PDF. Can you suggest a way, hopefully via a script, to set the defaults to the ones I want?

BAD BIG DAD

APC responds: We share your pain. Part of the problem is down to the fact that Windows often leaps in when older programs attempt to grab the file associations – this behavior has been blocked since Windows 8 (allegedly for security reasons), and when Windows detects this, it moves swiftly to reset the defaults back to its own choices. If you're lucky, the next time you double-click a file of that type you'll be given the opportunity to make your choice of app from the drop-down menu, but if not, you've got to right-click the file and choose "Open with > Choose another app" to set it to your choice of program again.

Workarounds have been developed that tweak the Registry or run command-line tools, but tend to break from one version of Windows 10 to the next. Another trick that might work is to remove the Microsoft apps that Windows tries to revert to: Photos, Groove Music, Films & TV, Edge, and so on (basically, the option marked as "Recommended for Windows 10"



Instruct Acronis Ransomware Protection to trust Ventoy.

under Default Apps). Not all can be removed through “Settings > Apps > Apps & Features” so you’ll either need to Google for the commands required to manually remove them using PowerShell (for example, “Get-AppxPackage *photo* | Remove-AppxPackage” for Photos), or use a third-party uninstaller such as IObit Uninstaller Free (<https://bit.ly/MPCOctiobit>).

Screensaver images

I have two unrelated questions: first, I have a collection of screensavers on discs from Second Nature Software. When I try to install these, it tries to validate from the website. The problem is that the company has been out of business for a long time and the website has been shut down. Is there any way to bypass the validation? Second, I keep getting requests to update Java. Is Java even needed any more? If needed, should I be installing the updates?

RICH T

APC responds: Second Nature’s screensaver is basically a slideshow of individual pictures, stored in its own proprietary SNX format to prevent people copying the files. If the pictures are visible on the CD as SNX files, then copy them across to a suitable folder on your hard drive.

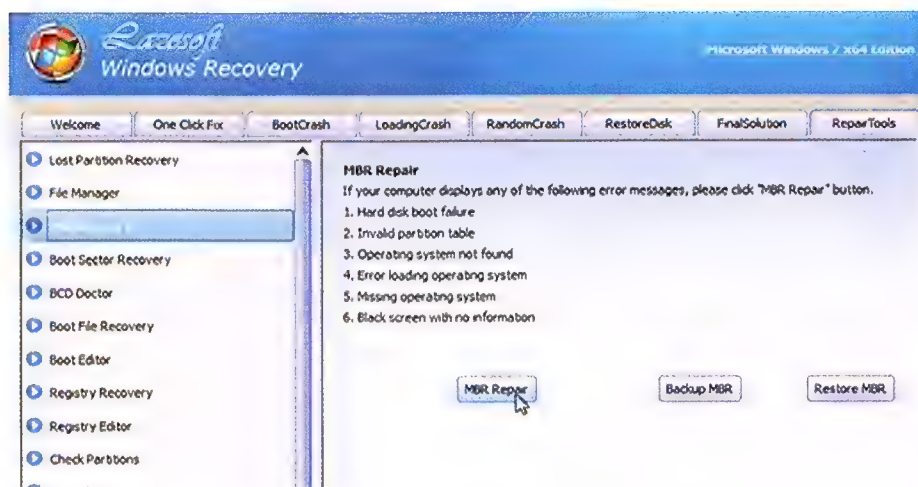
Next, download and install the free sampler version of the Second Nature screensaver from a reputable site like <https://downloads.cnet.com> –Google “Second Nature Screen Saver” to locate a link.

During setup you’ll be prompted to enter your email address – this goes nowhere, or you can add a fake email if you prefer. Once the program is installed, launch the tool from its Notification area taskbar icon, click the “Collections” button and choose “Create Collection.” Make sure “Second Nature Images” is selected as the file type, then browse to the folder containing your SNX images and click “Select.” The images should then be added to the program, which you can use as your screensaver.

As for Java, if you’re sure you have no programs on your PC that require it to run, simply remove it. Should you later need it, go to www.java.com to download the latest version. If you plan on keeping it, make sure you install the latest updates for security reasons, as well as to fix bugs.

Ventoy gets blocked

I tried to install Ventoy just now but kept getting blocked by Acronis



Lazesoft can recover most Windows installations.

Ransomware. It said an attempt was being made to alter the MBR, and it blocked it. Not knowing enough, I respected it and pulled out of the install. Is this an okay thing to happen?

DAVID THIEL

APC responds: Ventoy is 100 percent legitimate. The problem here is Acronis Ransomware 2018, and the way it works to protect your PC from potential ransomware attacks. It doesn’t rely on definition updates, but instead works on heuristics – namely, the behavior of your apps. It analyses a program’s actions, then compares it with a database of malicious behavior patterns – if it spots something that appears to match ransomware behavior it’ll block it. Clearly Ventoy’s attempts to modify your USB flash drive’s MBR are misinterpreted as malicious.

You can instruct Acronis to trust Ventoy. Right-click the Acronis Taskbar Notification area icon and choose “Manage processes.” Click “Add Application” to browse for and select “Ventoy2Disk.exe,” which will automatically add it to the Trusted list (you can reverse this later by rolling over the program entry and clicking “Block”). Note, you’ll need to repeat this every time you update Ventoy – make sure you do this before attempting to update your flash drive, or you may end up losing everything on the disk.

Non-booting laptop

My daughter’s Dell Inspiron N5040 laptop went from booting normally on the C drive to not booting at all and only showing an error message for drive X. As she no longer has the original Windows 7 installation discs, I tried the Lazesoft Recovery you’ve mentioned including its

“final solution” but to no avail (message says it cannot fix it). What caused the HDD drive to change from C to X, and how do I fix this?

MANUEL A TRUCCO

APC responds: When you boot into the recovery environment, it automatically assigns your Windows partition the X drive letter – so whatever problem your daughter has, that’s not it. First, use Lazesoft Recovery’s drive-imaging tools to make a failsafe backup of the drive’s contents, so they’re protected.

Assuming you’ve worked your way through the whole gamut of repair tools offered by Lazesoft with no success, your final option is to wipe the drive and start again from scratch. You can try restoring the laptop to factory defaults by selecting “Repair Your Computer” followed by “Dell Backup and Recovery.” If this is missing, contact Dell directly to see if it’s possible to purchase replacement recovery discs. Otherwise, you’ll need to source your own copy of Windows 7 (or later) to install a fresh copy of Windows on the drive and start from scratch. Inspiron N5040 drivers are still available for download from Dell’s support website should you need them.

Confused by logging

Last issue, you said to turn on logging by selecting “Logging” under options. I don’t see that option in Open Hardware Monitor 0.9.5. What am I missing?

AL KRAYBILL

APC responds: Apologies, Al. The option is “Log sensors.” Once switched on, the log file is stored in the “Open Hardware Monitor” folder. ■

Revamp the Start Menu with Open Shell

Improve its form and features, with Alex Blake.

Since bringing back the Start menu with Windows 10, Microsoft has tweaked and updated its app launcher numerous times. But if it still doesn't quite hit the spot for you – and if you really miss the old-style Start menu – there is an alternative in the form of Open Shell.

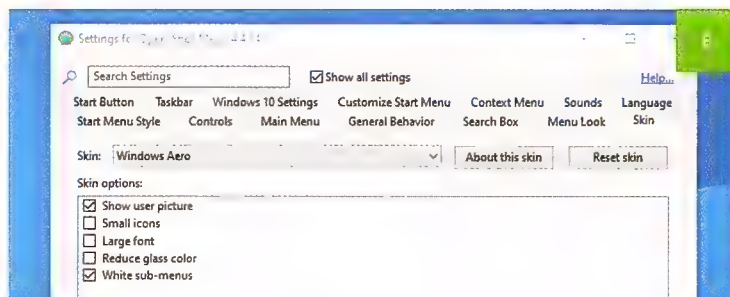
This free app brings back the pre-Windows 7 Start menu, giving some retro flavor to your PC. Open Shell gives you lots of different styles to play with, includes several different Start button options, and can even tweak other elements like the taskbar. It spun off from Classic Shell, which ceased development in late 2017. You can still download Classic Shell, but it is better to stick with Open Shell since it is actively updated by a team of developers.

Settings are organised into two rows of tabs at the top of the program, each containing myriad options to tweak and tune (make sure you click “Show all settings” to display extra tabs). If you're not sure where to find a setting, there's a built-in search box as well. With so many settings available, Open Shell is a great way to add visual flair to your Start menu.

1. Download and install

Open Shell is hosted on GitHub, a repository of code and various apps and tools. Go to the project's home page at <https://github.com/Open-Shell/Open-Shell-Menu>, scroll down to the “Download” section, then click the download button. On the next page, click the EXE file in the

YOU'LL NEED THIS:
Open Shell and
Windows 10



“Assets” section to download the installer. Once you've done that, run the installer file and follow the on-screen instructions to install Open Shell.

Upon clicking the Start menu, you'll notice it has automatically changed to the old-style menu. Gone are the Live Tiles, replaced by a much more compact menu reminiscent of the days of Windows 7 and before. If at any time you want to temporarily switch back to the Windows 10 Start menu, click “Start Menu (Windows)” at the top of Open Shell's Start menu. If you are happy with things as they are, there is no more you need to do. However, Open Shell has a lot of customisation tricks up its sleeve.

2. Set a Start menu style

In the Windows 10 search box, type “Open-Shell Menu Settings” (the hyphen is important) and click the top result. This will open on the Open Shell settings manager, with the “Start Menu Style” tab open and the “Windows 7 style” option chosen by default. Click either “Classic style” or “Classic with two columns” to try a different look [Image A]. Your changes will be applied.

As well as the menu itself, you can also alter the appearance of the Start button. You can change it to the Open Shell logo, the classic Start button (with text and the Open Shell logo), or a custom design of your choice. If you want to use the third option, click “Custom,” then click “Pick image...” and locate the file you want to replace the Start button with (transparent PNG image files work best).

3. Advanced appearance controls

One of Open Shell's main strengths is its ability to let you get really stuck in. The app gives you deep controls over the appearance of various elements, such as the Windows 10 search box, icon sizes, and more.

In the Open-Shell Menu Settings window, click the “Skin” tab. The default option in the drop-down menu is “Metro,” mirroring Microsoft's design language of the same name. Other options include “Classic Skin,” “Metallic,” “Midnight,” “Windows 8,” and “Windows Aero” [Image B]. You can also remove the skin styling entirely by clicking “<No Skin>.” When you choose one of these options, you can customise it further in the “Skin options” box, which allows you to make the menu opaque, increase the font size, use small icons, as well as other options.

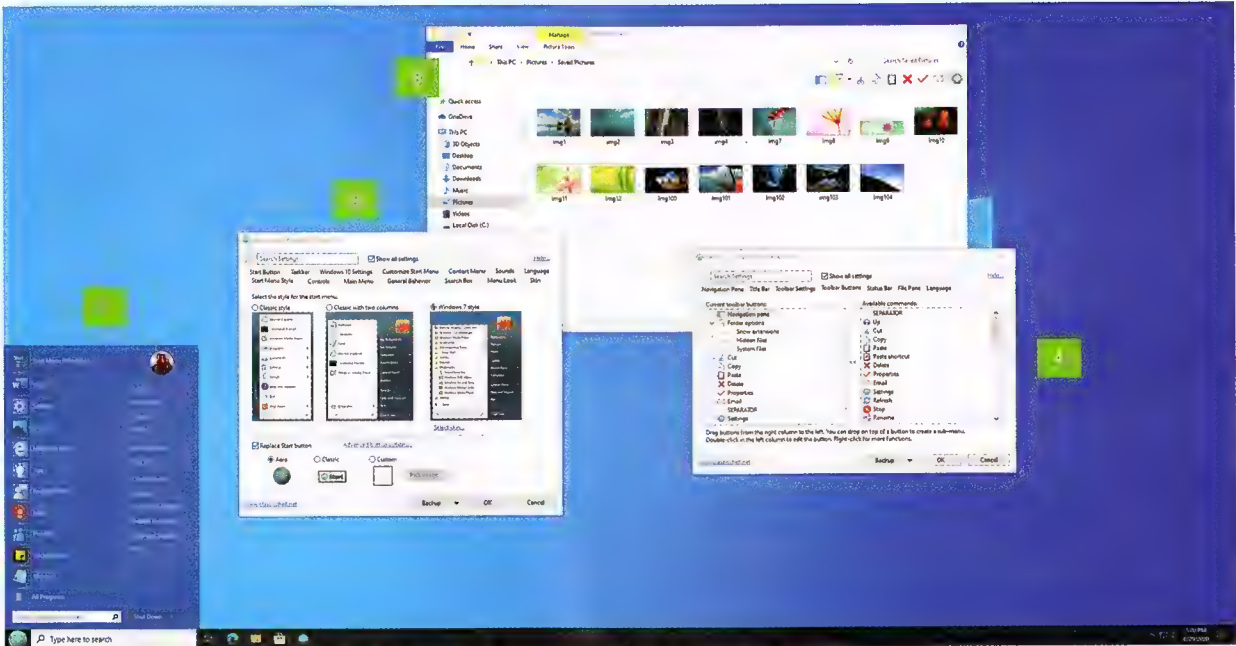
Next, click the “Menu Look” tab. Here, you can tweak settings in detail. There are options for changing the sizes of small and large icons, adjusting the Start menu's animation when you click the Start button, whether font smoothing is used, sub-menu scrolling speed, plus more.

If you want to add or remove a button from the Start menu, click the “Customise Start Menu” tab. Click the name of an item in the resulting list, and you can replace it with something else. Alternatively, you can click an entry in the “Display” column to change how it appears; choose between showing an item as a link, as a menu, or hiding it altogether.

>> In APC's October issue we discussed how to change your



Adjust Windows to your liking



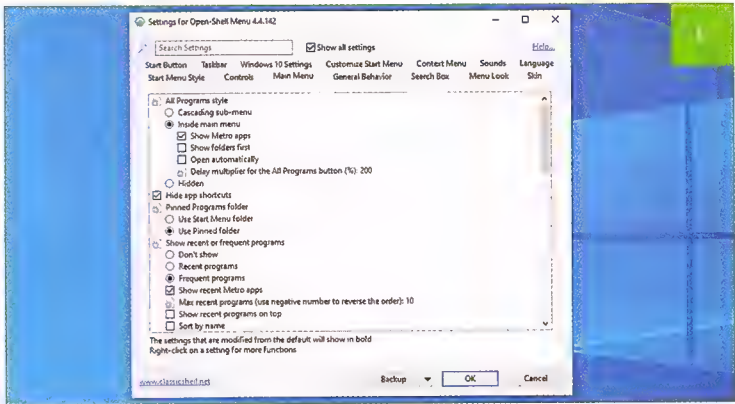
1. There are three main Start menu styles to choose from, including Windows 7 style, Classic style, and Classic with two columns.
2. Open Shell has a whole host of options to customize your Start menu. Tick the "Show all settings" checkbox to see them all.
3. Open Shell can also change the visual style of Windows Explorer. Click the logo in the top-right corner to access its settings.
4. The Windows Explorer Settings window contains useful tweaks, including changes to the status bar, file paths, toolbars, and more.

taskbar's appearance with TaskbarX. Open Shell can implement similar visual changes to the taskbar. In the "Taskbar" tab there are options to toggle between an opaque, transparent, or glass-effect taskbar (like in TaskbarX). You can also change the taskbar's opacity, colour, borders, and add a texture overlay.

4. Altering behaviors
Open Shell goes beyond the visual – it offers ways to change how elements of Windows 10 behave, too. In the Open Shell Menu Settings window, click the "Controls" tab. This tab governs what happens when you click the Start button, either with the left mouse button, right mouse button, or a combination of mouse and keyboard. For instance, Shift-clicking the Start button opens the standard Start menu instead of the Open Shell variant by default. As for the behavior of the Start menu itself, that can be tweaked in the Main Menu tab [Image C]. This is useful if you want to hide the list of recently used programs, for example, or reverse the alphabetical sorting of apps. There are a lot of options in this tab, giving you a deep level of customisation that is not

normally possible using the built-in tools in Windows 10. Settings that alter how the search box on the Start menu behaves are (unsurprisingly) located in the "Search Box" tab. This provides a raft of deep-level settings at your fingertips. You can specify what you can search for and where Windows will look on your PC, toggle auto-complete on search queries, or hide the search box completely for a cleaner look. Note that this does not hide the search box on the taskbar, only the one on the Start menu. Even the right-click menu gets its own group of settings in the "Context Menu" tab. This lets you

remove certain options from the context menu – such as browsing to a program's location in Windows Explorer – or hide the right-click menu entirely (this only affects Open Shell and does not disable the context menu elsewhere). Fancy adding some audio effects to your Start menu? The "Sounds" tab lets you do this, enabling you to play sounds when you hover over the Start button, for example, or open a sub-menu. Finally, miscellaneous settings can be found in the "General Behavior" tab. For example, if you want to toggle whether newly installed apps are highlighted, or change the delay before tooltips. ■





MAC

Make your battery better

Increase your MacBook's battery life and on its health.

Battery life is the Achilles heel of any laptop and, while Apple has made huge strides with batteries, there's always room for improvement. That's why it introduced an iPhone-style Battery Health feature in macOS

10.15.5, although you'll only see it if your laptop has Thunderbolt 3 ports: older Macs don't have the necessary hardware.

Battery Health monitors your battery temperature and its charging patterns, and

IT WILL TAKE

5 minutes

YOU WILL LEARN

Where to find your battery's condition status and how to make it last longer

YOU'LL NEED

You'll need a MacBook, MacBook Air or MacBook Pro

it optimises charging in order to make your battery last as long as possible.

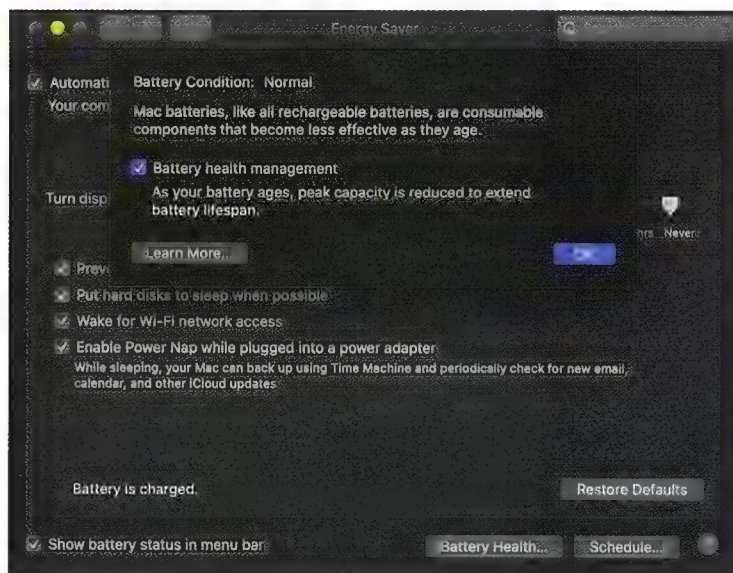
We don't mean last as long as possible between charges; we mean last as long as possible before you have to buy a new battery. Batteries become less efficient as they age, and Battery Health aims to reduce the speed at which that efficiency degrades.

Power anxiety

Doing that is a delicate balancing act, because prolonging battery life could mean slightly less battery life between charges. If that's a concern, you can disable the feature in System Preferences > Energy Saver > Battery Health.

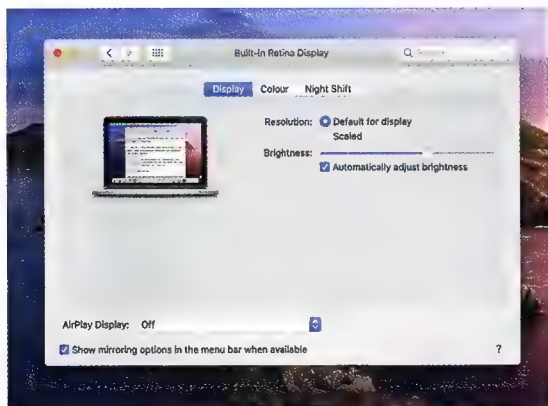
Of course, battery life isn't just a concern to people with relatively new Macs. We've all experienced power anxiety when we've got stuff to do and we're far from a plug point. The good news is that a few simple tweaks can make a big difference to any mobile Mac.

CARRIE MARSHALL



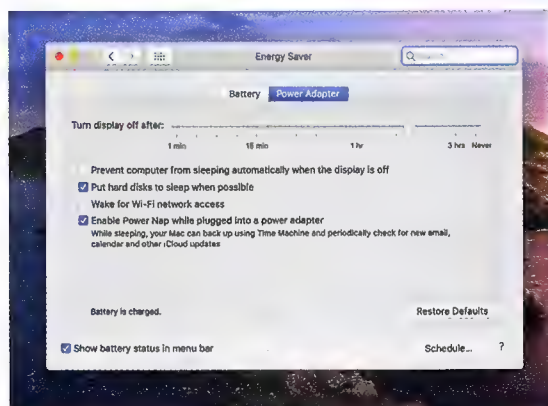
The new battery health feature will only appear in System Preferences if you have a relatively recent Mac; older ones lack the necessary hardware.

HOW TO Make your Mac last longer



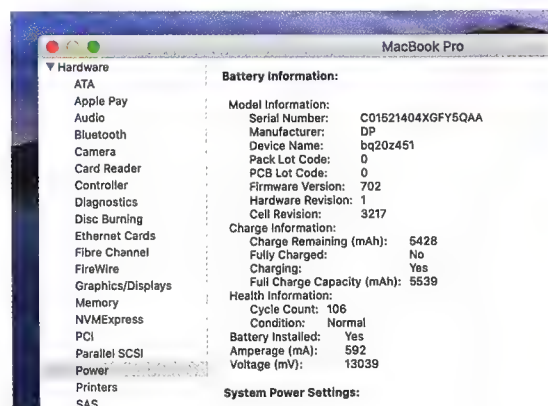
01 MAKE IT DARKER

One of the biggest power drains on any laptop is its display; eke out a bit more life from your battery by turning its brightness down. Unlike recent iPhones, Dark Mode won't help here: Macs use different display technology.



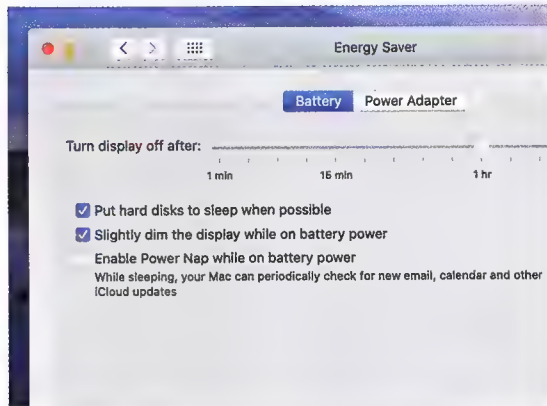
03 PLUG IN BABY

The settings that work best for long battery life don't always work for your Mac when it's plugged in. In the Power Adapter tab, you can specify different settings for your Mac when it isn't using its battery.



05 GET THE CYCLE COUNT

Select System Report > Power. In the middle of the window, you'll see a section marked Health Information. This tells you how many charge cycles your Mac's battery has completed and what condition it's in.



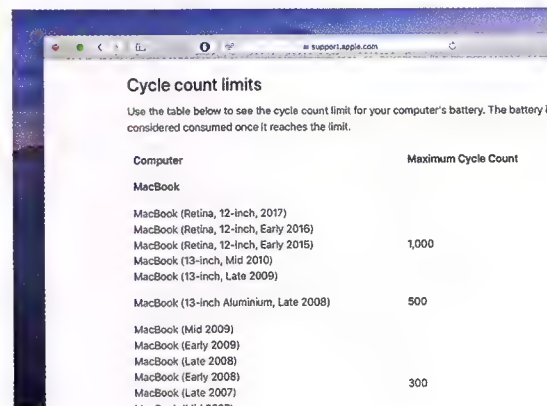
02 ADJUST ENERGY SETTINGS

System Prefs > Energy Saver is your friend here. This screen lacks a Battery Health button as this is an old Mac, but we can make changes. Under the Battery tab, disable Power Nap and make the display turn off more quickly.



04 CHECK THE BATTERY

Batteries become less efficient over time. Apple provides a way to check the condition. First of all, click on the Apple menu then on About This Mac. Take a note of the kind of Mac you have, such as the 13-inch Early 2015 here.

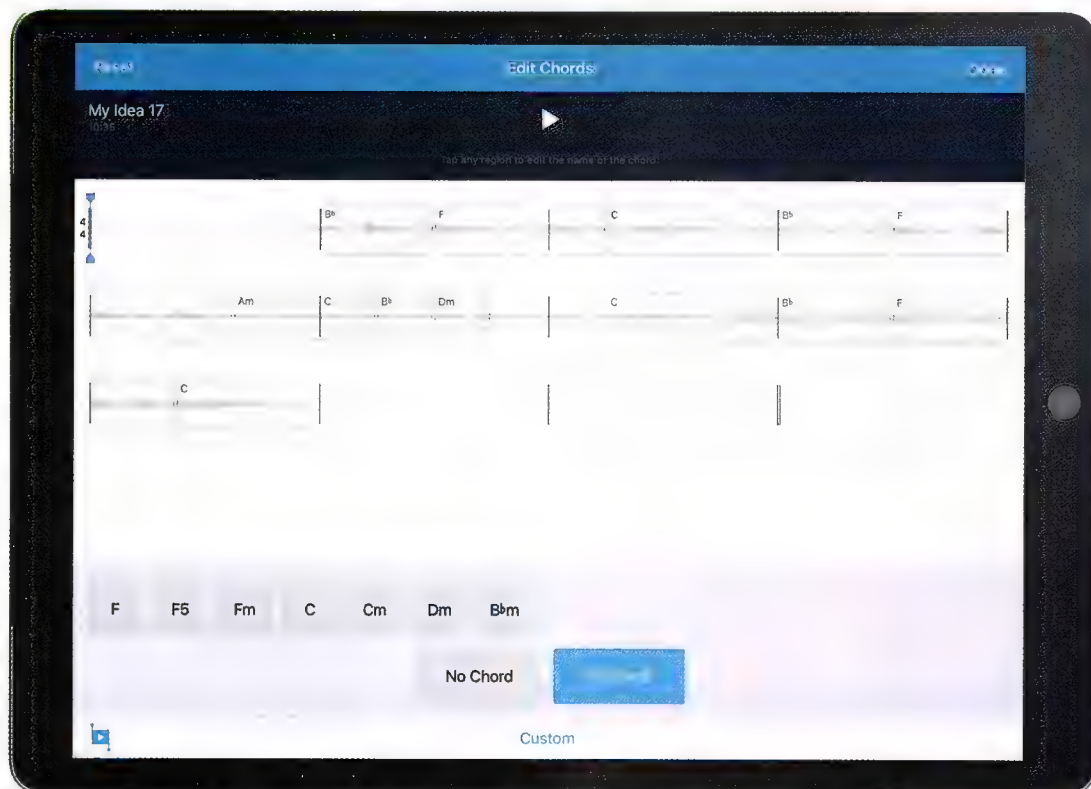


06 CHECK WITH APPLE

Apple has a list of batteries and how many charge cycles they're good for (the AU one is at support.apple.com/en-au/HT201585). Simply find your model; in this case, our battery shouldn't need replacing for another 800ish cycles. ■

JARGON BUSTER
Thunderbolt 3 is a connection technology for very fast data transfer. On Macs it's often used for external storage or displays.

GENIUS TIP!
In System Preferences > Users > Login Items, disable apps that automatically run at startup – and unplug any USB devices you're not using.



iOS

Take note in Music Memos

Master Apple's clever recording tool for your musical ideas.

If you're musically minded, you've probably used Voice Memos to capture ideas. But while Voice Memos is a great app it's also very basic. Apple's Music Memos for iPhone and iPad takes Voice Memos and adds stacks of

musician-friendly features to create a brilliant and useful app for guitarists and piano players.

The first thing you'll need to do is record your tune – and to do it in tune, thanks to the built-in acoustic tuner that works for all

IT WILL TAKE
10 minutes

YOU WILL LEARN
How to master Music Memos

YOU'LL NEED
OS 11 or later, something to play or sing

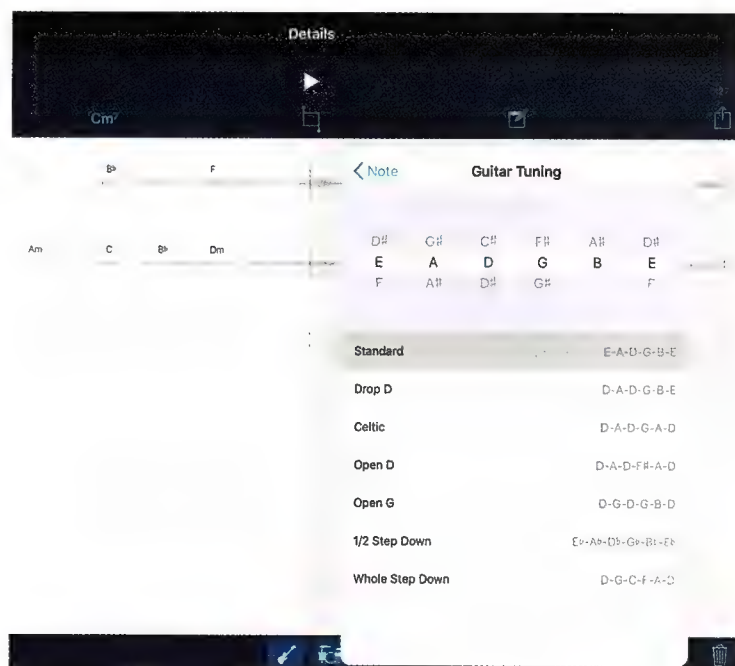
GENIUS TIP
Music Memos constantly adjusts the tempo to follow your playing, so you may see lots of tempo changes when you open your song in GarageBand.

kinds of stringed instruments.

When you play, Music Memos works out what chords or notes you're playing and enables you to add bass and drums to it: these automatically follow the tune, and you can adjust the sound and the playing style and get them to drop in and out to add interest to the arrangement. The chord recognition is pretty good, but it's not perfect – which is why Apple also gives you tools that you can use to change the detected notes or chords. Apple says it's optimised for acoustic guitar and piano, but we got good results with electric guitars and ukuleles too.

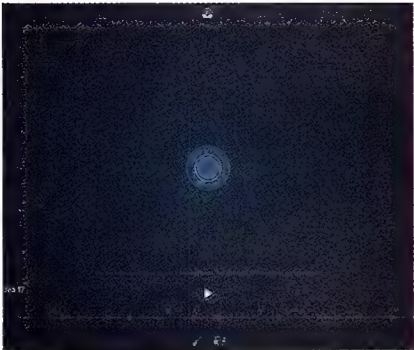
GarageBand or share
Music Memos may look simple but it's clever and very useful for songwriting. It's a great way to flesh out simple musical ideas to hear how they might sound in a band environment, and when you've got something you like you can share it as an .m4a audio file or open it as a new project in GarageBand.

CARRIE MARSHALL

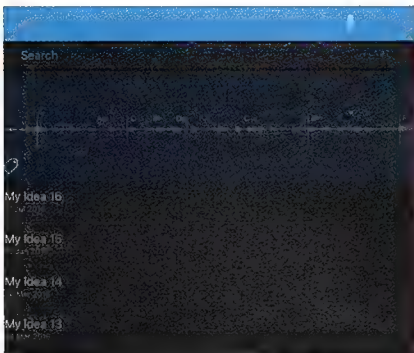


Music Memos isn't limited to standard tunings. It knows drop D, whole and half-steps down and open tunings too.

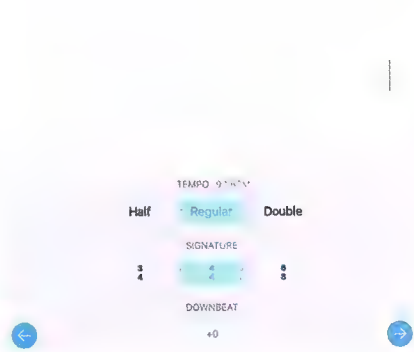
HOW TO: Make music with Music Memos



01 RECORD YOUR IDEA Tap the Tuner icon in the top right to check you're in tune and then either tap the big Record button or Auto. That latter option automatically monitors the internal mic or external device and starts recording when it detects sound.



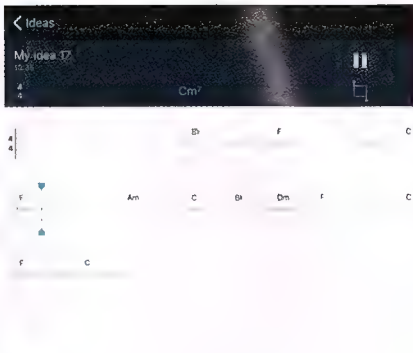
04 SEE YOUR STUFF All your Music Memos are stored in the drawer, which you can access by tapping the icon in the top centre of the main screen. It's best to give your recordings meaningful names, unlike our example! To edit a song, tap on it.



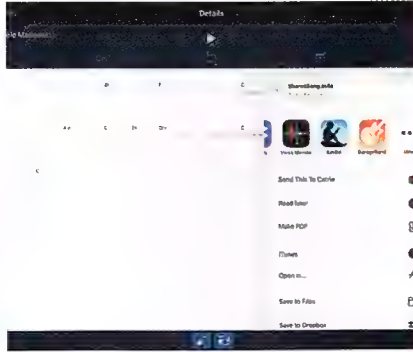
07 CHANGE THE TIME Music Memos doesn't support quite as many time signatures as GarageBand, but you can choose from 3/4, 4/4 and 6/8 time as well as half and double speed. You can also tell Music Memos where the first downbeat should be.



02 BRING IN THE BAND Music Memos can play along with your song. If you look at the bottom of the screen you'll see the icons for Bass and Drums to turn them on or off. If you long-press (shown here) you can choose the type of bass and the playing style.



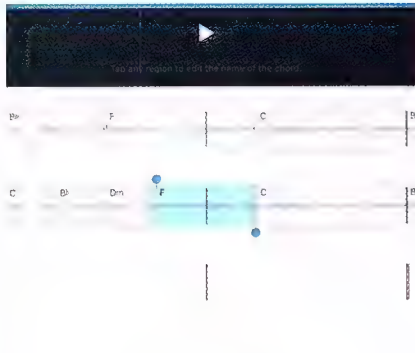
05 EXPLORE YOUR AUDIO Music Memos automatically detects the chords you're playing and shows them alongside the relevant bit of audio, which is handy if you're telling somebody else what to play. You'll see there's a little toolbar immediately above the music.



08 SHARE YOUR CREATION You can share your audio in two ways, both of which happen via the Share icon. The first is to send your complete track as a .m4a audio file, which you can send as a message or to an app. The second is to export to GarageBand.



03 DICTATE THE DRUMS You can change the drums in the same way. This is a simplified version of GarageBand's Drummer; you simply drag the dot to make your drums louder, quieter, simpler or more complex. You can choose different kits too.



06 EDIT YOUR SONG If you tap the Edit icon second from right, you can change the chord – which you'll have to do from time to time because Music Memos doesn't always guess correctly. You can also select No Band to stop the bass and drums.



09 TWEAK YOUR TUNE Music Memos creates a GarageBand project with three tracks: the recording and its bass and drum tracks. Those tracks are just normal GarageBand tracks, so you can move or edit the bass notes or tweak the Drummer settings. ■

Scheduling tasks

Want to make time for hobby projects such as uncovering the name of Doctor Who? Shashank Sharma suggests automating recurring tasks.

The Occam's Razor principle is often paraphrased as 'the simplest answer is often correct'. Although this has long been thought as something that applies to science, this principle can also be used to determine the best software solution to a given problem. This is why tools like Cron and At remain so popular for automating recurring tasks. Cron is used for tasks you wish to perform repeatedly, such as installing updates, or performing backups. The At utility, on the other hand, can be used to run tasks only once, at the specified time.

But that's something that would only appeal to system administrators, we can hear some of you earnest readers complain! Although a critical skill for any administrator, automation of recurring tasks can be every bit as useful for desktop users. For example, perhaps you want your certain critical data to be backed up every day, or wish to delete the contents of the Downloads, or any other directory every week to ensure you have enough free disk space. You could perform each of these tasks manually, but the downside is that you might forget to do so every so often.

Using Cron

An event that's scheduled to run at a specified time with Cron is called a Cron job. These events can be scheduled by editing the crontab file. The system wide file is located in the /etc directory. You can also create user specific Cron jobs, which are stored in the /var/spool/cron directory.

A crontab file may appear as no different than any other configuration file capable of being edited in any text editor, but you should only use the crontab -e command to edit the crontab file. This is because these files have specific formats, and running the crontab -e command ensures that all syntax errors in editing the crontab file are reported immediately.

The Cron daemon starts at bootup and runs a check every minute to see if any task is due. Each task in the crontab file is

Complete the following form to generate a crontab line

Ctrl-click (or command-click on the Mac) to select multiple entries

Minutes	Hours	Days
☒ Every Minute	☒ Every Hour	☒ Every Day
☐ Even Minutes	☐ Even Hours	☐ Even Days
☐ Odd Minutes	☐ Odd Hours	☐ Odd Days
☐ Every 5 Minutes	☐ Every 6 Hours	☐ Every 5 Days
☐ Every 15 Minutes	☐ Every 12 Hours	☐ Every 10 Days
☐ Every 30 Minutes		☐ Every Half Month

Months	Weekday
☒ Every Month	☒ Every Weekday
☐ Even Months	☐ Monday-Friday
☐ Odd Months	☐ Weekend Days
☐ Every 4 Months	
☐ Every Half Year	

defined in a new line. Each line comprises six distinct fields:

[Minute] [Hour] [Day-of-the-month] [Month] [Day-of-the-week] [command]

As you can surmise, you can set up a Cron job to run specific commands, or even execute scripts. The first five fields are used to define the exact date and time when a task should be run:

DEFINING A SCHEDULE	
FIELD	POSSIBLE VALUE
MINUTE	0-59
HOUR	0-23, WHERE 0 IMPLIES 00:00AM
DAY-OF-THE-MONTH	1-31
MONTH	1-12 OR JAN-DEC (YOU CAN USE FIRST THREE LETTERS TO DEFINE THE MONTH)
DAY-OF-THE-WEEK	0-7, WHERE 0 AND 7 CAN BE USED FOR SUNDAY. (YOU CAN ALSO USE FIRST THREE LETTERS TO DEFINE THE DAY)

ADDITIONALLY, THE CRONTAB FILE SUPPORTS THE USE OF DIFFERENT WILDCARDS:

WILDCARD	PURPOSE
*	MATCHES ALL VALUES
,	CAN BE USED TO DEFINE MULTIPLE VALUES FOR A FIELD
-	CAN BE USED TO DEFINE A RANGE OF VALUES FOR A FIELD
/	DEFINE INTERVALS

You can visit <https://crontab.guru> or <https://crontab-generator.org> if you need help mastering the different values used for defining cron jobs.

For each entry in the crontab, each of the five defined conditions must be met for the scheduled command or task to be run. This can also lead to curious situations if you define a value for the [Day of the month] as well as the [Day of the week]. Consider the 30 0 1 * 0 command crontab entry. Here, we've scheduled the command to run at 30 minutes past midnight on the first of every month, but only if the day also happens to be a Sunday. This event will thus not be executed until November 2020.

This is why it's far more common to define only one of these values, and use asterisks for the other. So, when an asterisk appears in the month field, the scheduled task will be run every month. Where an asterisk appears in the day field, the task will be run every day.

You can similarly use other wildcards to define a strict schedule for tasks to be run. The 30 0 * * 1-5 tar -cjf ~/projects-backup.tar.bz2 ~/Documents/projects crontab entry can be used to schedule a back-up operation to be executed at 00.30 every day and every month, but the days are restricted to weekdays only.

The 30 5,17 * * 2,6 tar -cjf ~/projects-backup.tar.bz2 ~/Documents/projects will perform a backup at 05:30am and 5:30pm

QUICK TIP

Days of the week are numbered 0-7 starting with Sunday, which can be either 0 or 7. If you think the week starts on Monday, use 1-7, otherwise use 0-6.

every Tuesday and Saturday of every month. The / wildcard can similarly be used to define interval. The 0 14 **/2 * [command] will execute the specified command at 2PM every two months. The 0 */2 *** [command] / entry can be used to schedule tasks you wish to execute every two hours.

You can have as many Cron entries as you want – just ensure that each entry is written in a separate line. When you're done, save the file and then exit the editor. Note that the entries in the **crontab** don't need to be arranged by date or time. You can add them in any order you want. The Cron daemon reads the entire file every minute to identify upcoming scheduled jobs and executes them.

For each entry in the **crontab**, you can also define multiple tasks or commands to be executed by using the && operators. For instance, the 30 0 *** command && command2 entry will ensure that both command and command2 are execute at 00.30am every day.

While the five fields are useful in strictly defining the schedule for Cron, you can alternatively use keywords to define specific time periods:

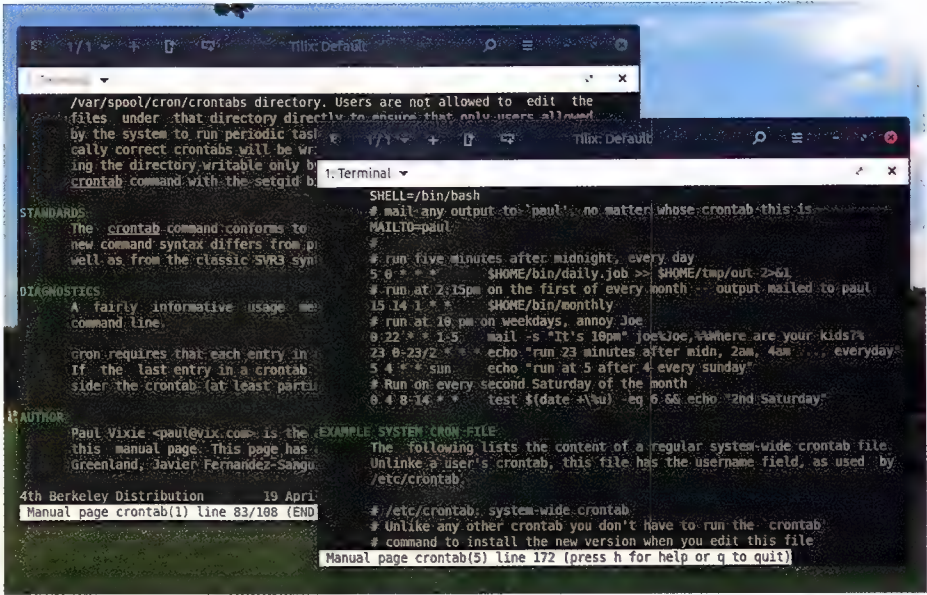
KEYWORD	MEANING
@REBOOT	RUN ONCE AFTER REBOOT.
@YEARLY	RUN ONCE A YEAR. SAME AS 0 0 11 *
@ANNUALLY	RUN ONCE A YEAR. SAME AS 0 0 11 *
@WEEKLY	RUN ONCE A WEEK. SAME AS 0 0 * *
@DAILY	RUN ONCE A DAY. SAME AS 0 0 * *
@HOURLY	RUN ONCE AN HOUR. SAME AS 0 * * *

The **crontab -l** command can be used to list all the scheduled jobs.

Cron alternatives

The one obvious disadvantage of Cron is that it requires for the computer to be up and running. If your computer is switched off at a time when a scheduled job was to run, the task won't be executed until the next time when it matches the defined parameters. For instance, a task scheduled to run at midnight every Wednesday won't be run until the following Wednesday.

You can use Anacron for such situations, or for tasks for which you don't need to define precise times. Unlike Cron which can be



Run the man crontab and the man 5 crontab commands for instructions on how to properly create entries for managing scheduled tasks.

Working with at

The at utility can be used to schedule tasks that need to be run just once. Scheduling jobs with at is easy because it accepts a variety of time formats. You can use keywords such as 'now + 1 hour', 'tomorrow', 'oct 30', '2pm tomorrow', and 'noon +3 days' to define the execution time for jobs.

When you run the at <time> command containing the date, you'll be dropped to the at prompt. Here you can enter the command or commands you wish to run. If you want to run multiple commands, press Enter after typing each. Press Ctrl-D when you're done. You'll be informed that a job has been created to executed the entered commands, and at also confirms the time when said job would be executed:

```
-> at 5pm tomorrow
warning: commands will be executed using /bin/sh
at> mkdir ~/Desktop/tempdire-should-be-deleted
at> <EOT>
job 5 at Wed Jul 15 17:00:00 2020
-> atq
5      Wed Jul 15 17:00:00 2020 a linuxlala
4      Wed Oct 25 12:30:00 2020 a linuxlala
->
```

The atq command can be used to print a list of scheduled jobs, and you can delete jobs with the atrm <job number> command.

“Cron is used for tasks you wish to perform repeatedly, such as installing updates, or performing backups. The At utility, on the other hand, can be used to run tasks only once, at the specified time.”

used to define the exact schedule for tasks, Anacron runs at startup. So if a task is missed because your computer was switched off, it'll be executed at the next reboot. Although not installed by default, you'll find Anacron in the software repositories of most distributions. Incron or Inotify cron is another popular Cron clone. Instead of

running tasks at specified times, it can be used to perform operations when certain changes are detected in the filesystem. For instance, tasks can be scheduled to run when a specified file is accessed or modified, a new directory is created, or a directory is deleted in a watched directory. ■

How to run Arch Linux on the Pi

Jonni Bidwell installs Arch Linux in less than three days and discovers the best way to browse the web is from the console.

The Raspberry Pi 4, thanks to its faster processor, USB connectivity and networking, is oft-touted as a desktop replacement. Be that as it may, we're going to show you how even an early model Pi can run a desktop... of sorts. We're going to use the community ARM port of Arch Linux to set up a lightweight desktop running i3. To add insult to injury, we'll combine the w3m browser, the mpv media player, and the popular youtube-dl script. This will enable you to browse YouTube (its many adverts and other streaming sites) from the comfort of a terminal window.

Arch Linux is generally recognised as being hard to install, and its ARM counterpart is certainly a far cry from installing Raspberry Pi Linux. However, once we've minted our SD card (which we'll soon see is a bit of a rigmarole), we pretty much have a working system. If you already have Arch installed on your PC, you can follow the second half of the tutorial to join in the console web-browsing fun.

Prepare the SD card

Arch Linux ARM don't provide an OS image that we can write (using Etcher or the like) directly to an SD card, they instead provide a filesystem tarball that we have to extract manually. So the first step is to prepare our media. We'll assume you're working on a Linux PC with an SD adapter (with at least a 4GB card inserted) for this part. We'll also use GParted (a `sudo apt install gparted` away if you don't have it) to do the partitioning for us, but if you want to use `fdisk` at the terminal, follow the official instructions at <https://archlinuxarm.org/platforms/armv7/broadcom/raspberry-pi-2>.

Open GParted and make sure the SD card is selected in the top right (it would be a grim start to the tutorial if you were to inadvertently delete hard drive partitions here). Make sure there's nothing you care about on the card and then delete all the partitions.

Create a new partition using the button in the top-left. Leave it as a Primary Partition, make it 100MB

YOU'LL NEED

- Raspberry Pi (any model)
- 4GB or more SD card
- Keyboard
- Mouse
- Monitor
- Wired network

and choose FAT32 for the filesystem. Then click Add. This will be our /boot partition. Create a primary data partition using the rest of the space, leaving the filesystem as ext4 this time. Hit the green check mark in the toolbar to apply the changes, heeding the subsequent warning.

Now open a terminal and mount our new partitions. SD partitions may be named as below, or as regular mass storage (for example, /dev/sdb2), or something else depending on your hardware. Use the `lsblk` command to make sure you get the right one:

```
$ sudo mkdir /mnt/piroot/
$ sudo mount /dev/mmcblk0p2 /mnt/piroot
$ sudo mkdir /mnt/piroot/boot
$ sudo mount /dev/mmcblk0p1 /mnt/piroot/boot
```

Now fetch the Arch Linux ARM archives. If you're running a Pi 3 or later, you may prefer to get the ARMv8 (64-bit) files instead in which case swap the 2 for a 3 (or 4) in the below:

```
$ wget http://os.archlinuxarm.org/os/ArchLinuxARM-rpi-2-latest.tar.gz
```

Extract the filesystem onto your newly created mountpoints. Don't be alarmed by the warnings about permissions (which the FAT32 partition can't handle).

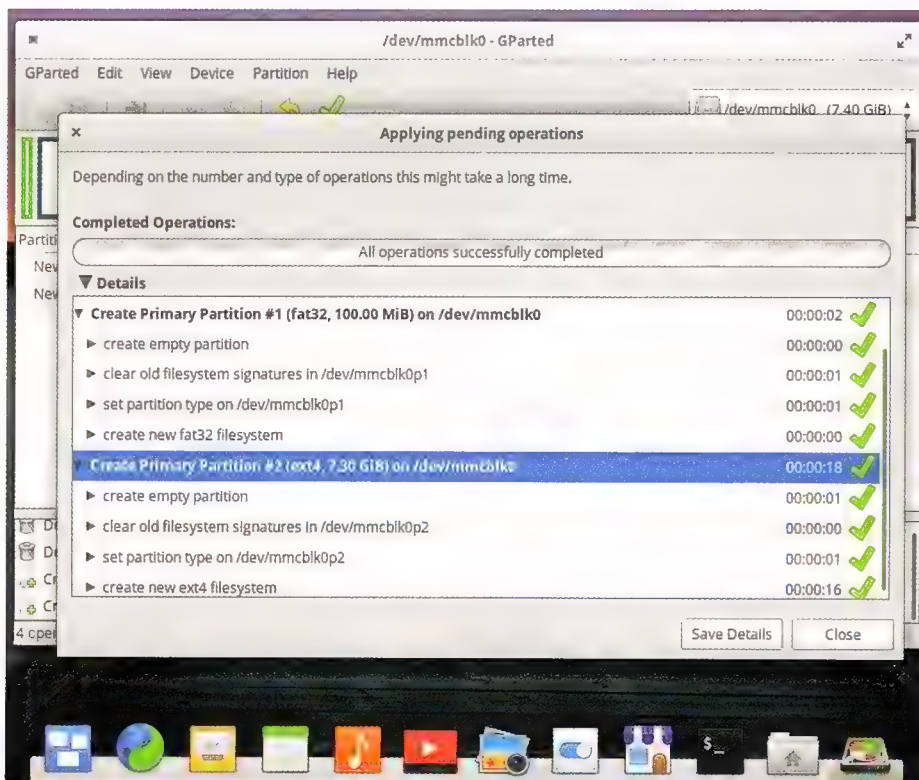
```
$ sudo tar -xpf ArchLinuxARM-rpi-2-latest.tar.gz -C /mnt/piroot
$ sync
```

It'll take a couple of minutes to extract all that data. While it's doing that, dig up a monitor, keyboard and USB power for your Pi. The second command ensures all cached data is written before you remove the card.

We won't cover setting up wireless here (refer to the Arch wiki for that), but we will cover other basic setup via Ethernet. Put the card in and boot your new mini computer. Log in with username and password `root` then update the package keyring and database. For good measure, we'll update the system too:

```
# pacman-key --init
# pacman-key --populate archlinuxarm
# pacman -Syu
It's good practice to set a system
```

Arch is all about doing things yourself, such as hand-crafting the partitions on an SD card.



locale at this point, otherwise we might run into all kinds of weird bugs later. To do this, edit the file `/etc/locale.gen` and uncomment a line that corresponds to where you are. Australian residents should choose `en_AU.UTF-8 UTF-8` for example. Then change `/etc/locale.conf` accordingly, so for Australia we'd say:

```
LANG=en_AU.UTF-8
```

Launch i3

Let's jump straight in to getting i3 up and running with:

```
# pacman -S i3
```

Then hit enter to install the whole i3 group (which includes a screen locker and status writing scripts).

We'll need the X.org server as well, but we won't bother with a login manager. Instead, you'll be starting the GUI from the terminal, which requires the Xinit scripts. We'll also need a terminal emulator, and we're going to go with the lightweight, but Unicode capable, `Urxvt` (aka, `rxvt-unicode`).

```
# pacman -S xorg-xserver
xorg-xinit rxvt-unicode
```

Now we need to create a simple `.xinitrc` in our home directory, so log out and log in as the standard user (username and password are both `alarm`, and you may want to create a new user later on).

```
$ echo exec i3 > .xinitrc
```

Consider modifying your `bashrc` if you want the GUI to start on login. Again, you'll find how to do this on this, as well as lots of helpful snippets for your `.xinitrc` file, in the Arch Wiki. You should now be able to start the display server with a simple `startx`.

Hopefully i3 will start, in all its minimal glory. Use the Super (Windows) and Enter shortcut to start a terminal. It will be full screen (and slightly imposing) because that's how tiling window managers are. See the box (right) for details of how to configure fonts and colour schemes. For now, we'll get on with setting up glorious console web browsing. Switch to the root account with the `su` and then add the final pieces and return to the normal user account:

```
# pacman -S w3m mpv youtube-dl
```

```
# exit
```

Feel free to have a play with `w3m`, for example, `w3m https://techradar.com`. You can navigate with the cursors, jump between links with Tab and open them with Enter. Check the manual for more.

Theoldnet.com reminds us of simpler times.

W3M can sometimes load more advanced sites, but this varies with the weather.

Anyway, `w3m` isn't quite ready for streaming video yet, so quit by pressing Q. `W3m` enables you to open URLs with different programs (so-called external browsers), so we'll set up the hotkey O to open files with the `mpv` media player. `Mpv` has bespoke support for `youtube-dl`, so after this quick change, we should be ready to go. Edit `w3m's` configuration file at `~/.w3m/config` and scroll down to the

`extbrowser` line. Change it to read `extbrowser /usr/bin/mpv -ytdl` and save the file. Now press O on video links and they should open in `mpv`! The ARM package for `w3m` may not give you a config file by default, but you can just use that line on its own.

Oh, and because it would be terrible to end this tutorial without showing you how to get out of i3, Super-Shift-e is the combination you need! ■

“Arch Linux is generally recognised as being hard to install, and its ARM counterpart is certainly a far cry from installing Raspberry Pi Linux. However, once we’ve minted our SD card, we pretty much have a working system.”

Configuration stations

There's an awful lot of customisation that these tools deserve and not a lot of space to talk about it. For example, if you don't like i3's default font (or if, as was the case for us, it doesn't render properly) you can install the `Dejavu` fonts with

```
# pacman -S ttf-dejavu
and uncommenting the
font pango:DejaVu Sans Mono 8
```

line, and commenting the previous (and slightly amorphous) monospace font declaration, in `~/.config/i3/config`. Check the documentation for any other changes you might like to make here.

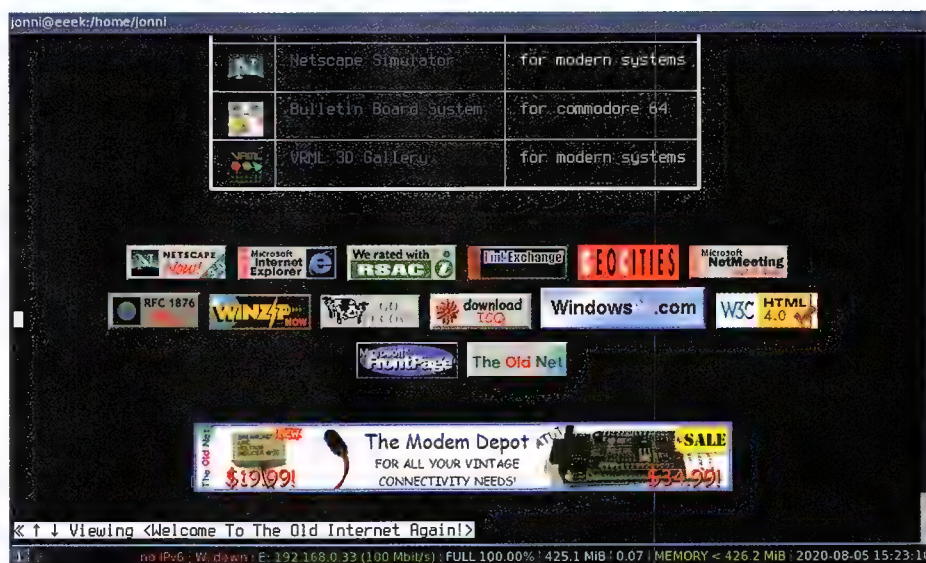
`Urxvt` is configured by the `~/.Xresources` file. To change it to a hacker-style dark background and have a right-handed, simple scrollbar, use the directives:

```
Urxvt.background: black
Urxvt.foreground: white
Urxvt.scrollstyle: plain
Urxvt.scrollBar_right: true
```

To re-read this file without having to log back in, you can do:

```
$ xrdp .Xresources
```

Again, volumes have been written about beautifying your terminal through this file, and we'd encourage you to check those out.



QUICK TIP
Switch between the four default workspaces in i3 by using Super-1 to Super-4.



Xbox Game Pass for PC has exited beta

...AND THE PRICE IS GOING UP.

Xbox Game Pass for PC has been bizarrely cheap since it launched into beta last year: an initial \$1 trial month rolled into a \$5 per month subscription, which was more than worth it for a library of over 100 games. But all good things must come to an end, and since mid-September, Xbox Game Pass for PC has exited beta and its monthly price is now double.

It's not unexpected: the \$5 per month was always a limited offer and the usual \$10.95 is about what you'd expect to pay for a subscription service. For reference, in the US Netflix Standard is US\$13, and Spotify is US\$10.

According to an official tweet, the service will enter 'General Availability,' which seems to suggest that it'll be available in more regions, though at the time of writing these regions aren't specified anywhere.

No Man's Sky studio hints at major new project

HOW DOES ONE FOLLOW UP A UNIVERSE SIMULATOR?

No Man's Sky was a hugely ambitious project for UK-based Hello Games: it offered a virtually infinite universe to explore, and since its initial release in 2016 it has evolved from a slightly boring survival game into something more akin to *Minecraft*. In September, Hello Games released its first new project since *No Man's Sky* in the form of *The Last Campfire* – a charming, relaxing and comparatively easy-to-develop puzzle adventure.

But that's not how the studio plans to proceed into the future. In an interview with *Polygon* last month, studio head Sean Murray promised that planning has commenced on another "huge, ambitious game like *No Man's Sky*." How a small independent studio follows up delivering a whole virtual universe, will be interesting to see.



GAMING NEWS

Fortnite goes next-gen with ray-tracing

A new Nvidia patch adds RTX and DLSS tech.

Ray-tracing makes a remarkable difference when applied to age worn titles: take *Minecraft* for example, which is truly impressive. Now Nvidia and Epic Games have teamed up to implement ray-tracing and DLSS tech in *Fortnite*. The patch applied ray-traced reflections, global illumination and more to the game's core battle royale experience, as well as to its creative and 'Save the World' modes.

If the patch doesn't make immediate sense after booting it up, Nvidia has created its own *Fortnite* map dedicated to showcasing the new tech – much as it did with *Minecraft*. The 'RTX Treasure Run' map is basically an interactive museum exploring the potential of ray-tracing in the popular free-to-play shooter, and you can access it completely free providing you own an RTX card that can actually run it.

Take-Two CEO is thankful the company didn't 'waste any money' on VR

Strauss Zelnick is doubtful about cloud gaming, too.

There's one game industry executive who doesn't have any enthusiasm for VR, being Take Two Interactive CEO Strauss Zelnick. Asked about the potential impact of cloud gaming, and Stadia in particular, he said in an interview with *Protocol* that "any new distribution vehicle that offers high-quality, efficiency and a reasonable price is good for our business," but also used VR as a cautionary tale about getting too caught up in the hype.

"There was all this hype for years about VR, and I wasn't very compelled by that," Zelnick said. "Thankfully, as a result, we

didn't waste any money on it."

He expressed similar doubts about the impact of cloud gaming, saying that he suspects "it will not be transformative."

"There were some parties who were saying there are 130 [million] to 140 million current-gen consoles out there. There are billions of PCs out there," Zelnick said. "You know, if you can make in a frictionless way console video games available to everyone who has a PC or a tablet or a phone, then your market size automatically would be 20x just mathematically."



Fall Guys is adding a giant hammer named Big Yeetus to “shake things up”

By shake things up, they mean shoot you into the stratosphere.

If you’ve enjoyed *Fall Guys* but at one point thought you’d enjoy it a lot more if it had a massive hammer that randomly appeared to send you flying, you’re in luck.

As the game’s Twitter account detailed, developer Mediatonic is “working on a little something that we have been calling Big Yeetus,” adding that “Big Yeetus will randomly appear in levels to shake things up.” The attached GIF suggests that Big Yeetus can spawn at the end of Dizzy Heights as a way to catapult you forward, bypassing some of the obstacles.

As much as I love just saying and indeed contemplating the words Big Yeetus, this joking piece of news is actually pretty significant. Up until now, Mediatonic has only made incremental balance changes to *Fall Guys* stages, or expanded them through new, redux stages like Jump Showdown. Big Yeetus, meanwhile, is a modular obstacle that can seemingly be added to multiple levels at random, which is an exciting direction for the game to explore.

EA reportedly plans to announce the *Mass Effect* trilogy remaster in October

“I’ve seen more than enough evidence to know it’s real.”

The highly-anticipated *Mass Effect* trilogy could be released as soon as October – but delays caused by Covid-19 may push it back to later in the year.

It’s long been rumoured that BioWare was looking to remaster the fan-favourite trilogy for a new generation of consoles and players, and fans are already excited at the news that BioWare is working on a new game from one of its “most prestigious franchises”... even if we don’t yet know what franchise that is. Now, however, a journalist has gone on the record to confirm that

publisher EA had planned to release the remaster – which is more likely to be an upgrade rather than a full remake – in October.

“Up until, like, this last week, I know the plan for sure was to announce it in early October, release later in October. So good news,” *GamesBeat* journalist Jeff Grubb explained on a recent podcast (thanks, VGC). “Maybe bad news – it’s 2020 – maybe that could start to slip, it sounds like maybe that’s a possibility, nothing for sure yet.”

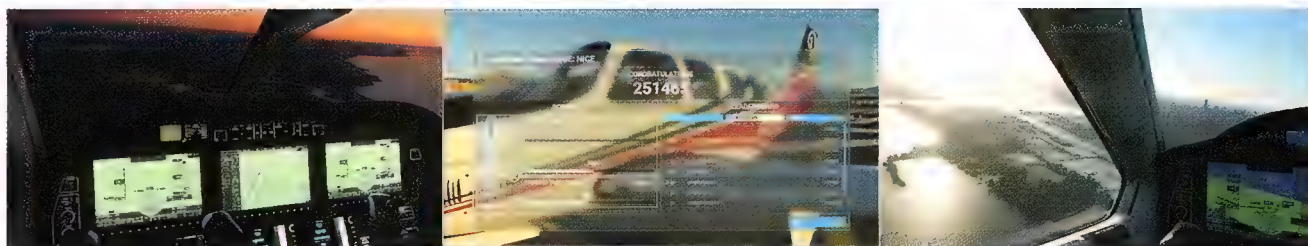


Sea of Thieves is getting dogs, and yes, you can pet them

For many, Rare has announced its most important *Sea of Thieves* update: dogs. Woofing, circling, huggable good boys and girls. That’s right – not only can you pet the dogs, you can hug them. It might not be the most piratey thing to do, but what kind of monster could resist? There’s also a new and permanent voyage being added for *Gold Hoarders*, which Rare says we’ll hear more about at a later date.

Hitman 3 out January 20, includes free next gen upgrade if you buy digital

This means that Xbox owners who choose to download *Hitman 3* will get the game on both Xbox and Xbox Series X via Microsoft’s Smart Delivery service. With Sony offering no such service, PS4 owners will need to purchase the game digitally, and then developer IOI will allow them to download *Hitman 3* on their shiny new PS5 without coughing up any cash.



\$99.95 - \$179.95 | PC | microsoft.com

Microsoft Flight Simulator

Taking 'open world' very seriously.

Do you ever wonder how it'd feel to take a few years away from games, and then peek back through the curtain once you'd become out of touch? Quite often, *Microsoft Flight Simulator* feels like that peek. In its scope and fidelity, it seems to be visiting from the future, when it's commonplace to have access to a photorealistic Planet Earth and the freedom to explore it. When you can hop in a plane and fly over your own town, in the same weather conditions and lighting you can see outside your window.

What a dramatic way for the *Microsoft Flight Simulator* series to reappear, and what a towering achievement from Asobo Studio. We'll be talking about the impossible detail of its 1:1 world map for years to come; reading retrospectives about how this piece of software changed environmental design; wandering around other games that harness petabytes of real map data and Cloud AI grunt as a matter of course. This is a seismic moment

for PC gaming then. But what's abundantly clear is that this is very much the beginning of *Microsoft Flight Simulator's* journey, one moment on a roadmap that includes regular content updates on a monthly cadence and should by necessity also include just as many to fix some considerable teething technical issues.

A total of 20 planes are included with the standard edition at launch, comprising three airliners, two jets and fifteen props. Using any one of those planes, you can position yourself on the runway of any airstrip in the world, take to the skies, and see a startlingly accurate recreation of the region below.

It's a premise with an appeal way beyond the flight sim's usual remit. Who wouldn't want to fly around in a playable, 4K, lightmapped version of Bing Maps with volumetric clouds and incredible weather effects? Who could resist the urge to try and



find their own house?

Its approach to teaching you how to fly a plane isn't that of a teacher, but a classroom. There's everything in here you could possibly need if you wanted to learn how to set a flight plan with ATC, power up an airliner from scratch, set a VOR vector up to cruise altitude and then an ILS approach in order to land again at your destination. However lost you might feel in the captain's seat, staring at a mass of blinking warning lights, you always want to figure it out. There's such intrinsic satisfaction in piecing together the puzzle of operating an aircraft. After a few hours you're raising the crash level and setting the source to BATT without even thinking about it.

An instant all-time-great.
PHIL IWANIUK

An incredible exploration portal with even greater potential once its tech issues have been addressed.

★★★★★



\$TBA | PC, PS4, XB1 | mortalshell.com

Mortal Shell

A budget *Dark Souls*-like that punches above its weight.

Set in the dismal fantasy world of Fallgrim, *Mortal Shell* puts you in the role of a nameless, skeletal creature arisen from an abyssal plain for purposes that are typically opaque. The only clarity you receive is provided by a giant trapped in a tower, who asks you to retrieve three “sacred glands” from various points in the world, which contain a hallowed substance known as Nektar.

Combat is as you’d expect from a game of this ilk, a mixture of light and heavy attacks, blocking, dodging and getting the shit kicked out of you. But there are some differences that, when combined, have a profound impact on the flow of battle. In your natural, skeletal form, you’re about as robust as a cardboard box in a storm. Luckily there are corpses scattered about the world, deceased warriors who, once discovered, can be possessed and reanimated.

Mortal Shell’s boldest change to the *Souls* formula is that there’s no Estus Flask equivalent. Instead, your main method of restoring health in a fight is by parrying. Using a special talisman, you can deflect enemy attacks and use the resulting

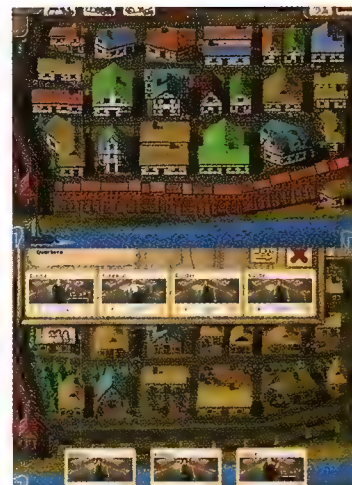
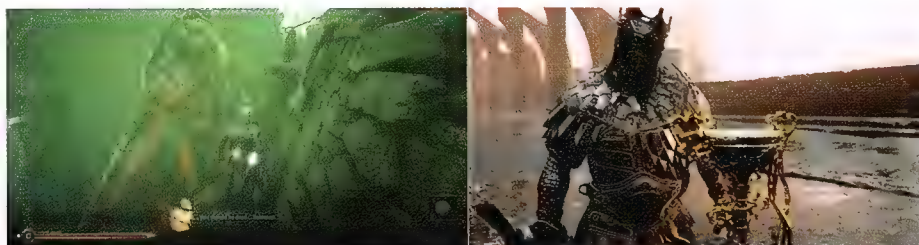
opening to drain a chunk from enemy health bars. While initially tougher than *Dark Souls* due to the absence of a main healing item, once you figure out the rhythms of hardening, parrying, and dodging, it’s possible not just to survive *Mortal Shell*’s enemies, but to annihilate them. These features bring fantastic dynamism in *Mortal Shell*’s combat, and the result scratches that *Dark Souls* itch.

Everything else about *Mortal Shell* is decent, but could be improved. With locations and environments, most of the budget seems to have been spent on one area, a sprawling obsidian temple that starts out weird and gets increasingly surreal the deeper you explore. Everywhere else is mundane by comparison – forests, ice caves, catacombs. It’s all nicely sculpted, but lacking in imagination. *Mortal Shell* is no masterpiece, but it’s a capable fighter nonetheless.

RICK LANE

Enjoyably tough and esoteric, if a little uneven, *Mortal Shell* is a strong debut and a worthy *Souls*-like.

★★★★☆



Free | PC

scriptwelder.itch.io/waterworks

Waterworks!

Bringing water to a medieval town.

Part citybuilder, part card game, part turn-based management sim, *Waterworks!* is an inventive browser game that tells the history of a settlement – or the liquid part of it at least. The medieval town of Grudziadz is struggling to provide clean drinking water to its residents, and you’ve been brought in to help, first with literal buckets of river water and later with more sophisticated infrastructure including wells and pipes.

With the town’s houses fixed in place, you’re left to sort out the routes of water carriers, to build off-screen structures and lay pipes at strategic points, and each action costs you valuable cash and resource cards. You can only achieve so much before you run out of resources, though each new turn does out more money and refills your hand. Typical cards include foremen, builders and scribes, carriers, wagons and sumps, and various gifts to or from the local ruler.

Waterworks! is simplistic and fairly linear, but it commits to its theme of water distribution in Poland. It’s not dry, despite that. Quite the opposite, it’s full of life: a tableau of the medieval world.

TOM SYKES

History comes to life in this satisfying management game that wrings plenty of ideas from its water theme.

★★★★☆



Free | PC | locomalito.com

Solar Gladiators

Scratches that arcade itch.

Locomalito's latest freeware gem is arena shooter *Solar Gladiators*, which pits your discus-flinging hero against a procession of monstrous bosses, with just one life and a persistent health bar to fret about. It's a little bit *Tron*, in that your sole weapon is essentially a high-tech boomerang, and a wee bit *Smash TV*, but without its famous twin-stick control scheme. *Solar Gladiators* is comfortably its own thing, however. You're not fighting waves of baddies but taking part in a series of duels. Every level brings a new boss fight, with a fresh pattern to learn as you contend with the unique nature of each enemy. There's the big snake that zags around like its Nokia namesake, the immobile plant that endlessly regrows a defensive barrier, and the slime that insists on multiplying as you shoot it to bits.

There are 15 boss fights and a lot of effort has been put into making them feel unique. It's tough but not cruel, and lengthier and more varied than arcade games often were back in the day.

TOM SYKES

Like Locomalito's other games, this looks and feels retro, while being subtly informed by modern sensibilities.

★★★★☆



Free | PC | thunderlotusgames.com

Spiritfarer

A compassionate adventure that finds comfort in death.

Spiritfarer is a life sim about dying. You play as Stella, an upbeat ferry master who's responsible for finding and helping wandering spirits pass on into the afterlife. After inviting the spirits to stay on your boat, you take care of them and make sure they live comfortably. Then, when they decide they're ready to move on, you take them to a huge, ominous portal called the Everdoor and see their journey through to the end. Sometimes the goodbyes are easy, but, more often than not, they are bittersweet farewells to characters you've grown to love.

You're tasked with crafting a personal space for each resident, preparing their preferred foods, and keeping them happy with plenty of hugs. Very much in keeping with the life sim formula, you'll need to complete little tasks at all the boat's different stations – cooking, crafting, farming, weaving, smelting, etc.

It's because of these daily tasks that you get to know the characters closely in such a short amount of time, and as thanks for looking after them, the spirits teach you skills that help out with your chores. Through this

exchange, you develop a closeness to each individual, and they begin to open up about their past life. The backstories of your passengers are not the usual fluff you might see in community sims like *Animal Crossing* or *Stardew Valley*. They hit harder because these characters are, well, dead. They reminisce on their old lives, the families they left behind, good times, bad times, and of course, their own deaths. In this way, they are more than just boat passengers – they're friends, guides, and confidants.

Spiritfarer understands that dying isn't just about someone not being there anymore, it's about the ways you think back on them after they're gone. Thunder Lotus has managed to create a sim that deals with the topics of death and compassion with wonderful balance.

RACHEL WATTS

Spiritfarer is a thought provoking and bittersweet life sim that understands that death is part of living.

★★★★☆





\$28 | PC, PS4 | fallguys.com

Fall Guys: Ultimate Knockout



A cute yet still tense party royale.

Each round of *Fall Guys* begins with 60 players rushing through an obstacle course in a chaotic mob of jumping, diving, whooping, and ragdolling bodies. Only the first 30 or so across the finish line qualify for the next round, which is randomly chosen from about two dozen different levels. Each level eliminates more players until the final round, where anywhere from a handful to more than a dozen compete to be the sole winner.

For most of a match I'm content to goof around, take reckless chances and stop to celebrate with emotes before crossing the finish line. Getting ragdolled out of contention usually just makes me laugh. But as the end of the final round approaches I'm suddenly taking things seriously as hell. I may be a bean wearing a frilly pink tutu, but I want to win.

There are a few different types of levels. Races are the most common, and sometimes you'll engage in several footraces through various obstacle courses in the same match. The courses may have giant spinning fan blades to knock players back, ramps coated in slippery slime, spinning balance beams, or vanishing floor tiles, walls that

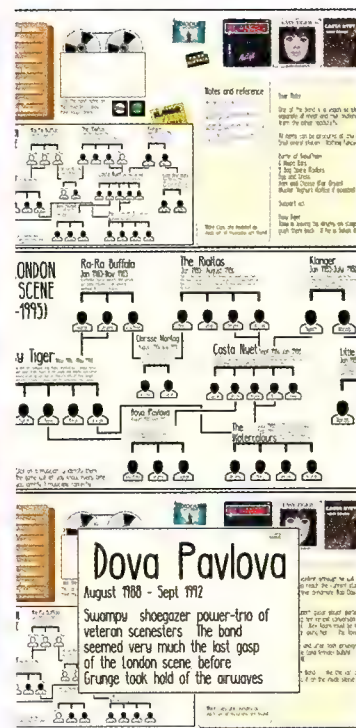
can be broken through, or giant pieces of fruit tumbling down the course, knocking players aside like bowling pins unless you dart and dodge around them.

It's so silly and breezy that if I'm eliminated because of shabby teammates, or if I get bonked into a pit because someone else blundered into a spinning fan and flew into me, I just laugh and shrug and queue up for another match. It's only in the final round where I care enough to swear. Damn that hot dog to hell.

Fall Guys is best enjoyed in small doses, and an hour of play a day is plenty. But that hour is usually great fun mixed with some delicious tension in the finals. It's an impressive feat to make a game so charmingly silly that's still filled with genuinely dramatic moments, heartbreaking losses and last-second acrobatic feats.

CHRIS LIVINGSTON

In a genre that is overstuffed with guns and grenades, this cute and cuddly battle royale stands out.
★★★★☆



Free | browser | owl-skip.itch.io/family

Family

Piecing together music history.

In the unusual detective game *Family*, you're trying to piece together a history, putting names to each of the players in the London pop scene of a couple of decades ago. It's the detective's 'serial killer' wall, but with a family tree of indie bands. Who played drums in *The Rialtos*? Who played guitar in *Easy Tiger*? Clues lie in snatches of a radio broadcast, in songs from the (fictional) bands, and in snippets of articles delivered piecemeal to your desktop, every time you guess any five musicians correctly.

As a detective game, *Family* makes you work for it. I resorted to a bit of guesswork at the end, but I was able to figure out most of the identities by really scrutinising all of the evidence. It trusts the player to play detective, as they exhume a forgotten scene from music history. More impressive, however, is the music itself. Developer Tim Sheinman has created a track for each of the nine bands from the '80s-'90s indie scene: that's nine songs that sound distinct from one another, and that feel pretty convincing for the era.

TOM SYKES ■

The march of time can be depressing, but *Family* finds joy in discovery, and meaning in its ritual of remembrance.
★★★★☆



DEVELOPER GREMLIN INTERACTIVE PUBLISHER IN-HOUSE RELEASED 1991 WEB bit.ly/30LzS36

Heroquest

I'll use my broadsword, says Jody Macgregor.

I don't feel nostalgia for many things, but when I fire up *HeroQuest* and the music suddenly flips into *Golden Brown* (imagine being a composer, told you only have 30 kilobytes for your entire musical score and thinking, "Cool, that means I can fit this harpsichord solo by *The Stranglers in*"), I feel a full-blown Proustian rush.

The ad for the board game version of *HeroQuest* has the same effect. Like a whole generation of baby dorks I saw those kids saying "I'll use my broadsword" and "Fire of Wrath!" and immediately asked my parents to buy it for me when Christmas rolled around. Then I played it with my parents, my

friends and my babysitter until everyone was thoroughly bored. Even my babysitter didn't want to play it any more, and she was paid to spend time with me. I kept playing by myself, keeping the board set up on a tiny table for one under the stairs, controlling all the monsters as well as a full suite of four heroes. Now that I think about it this is actually quite a depressing memory.

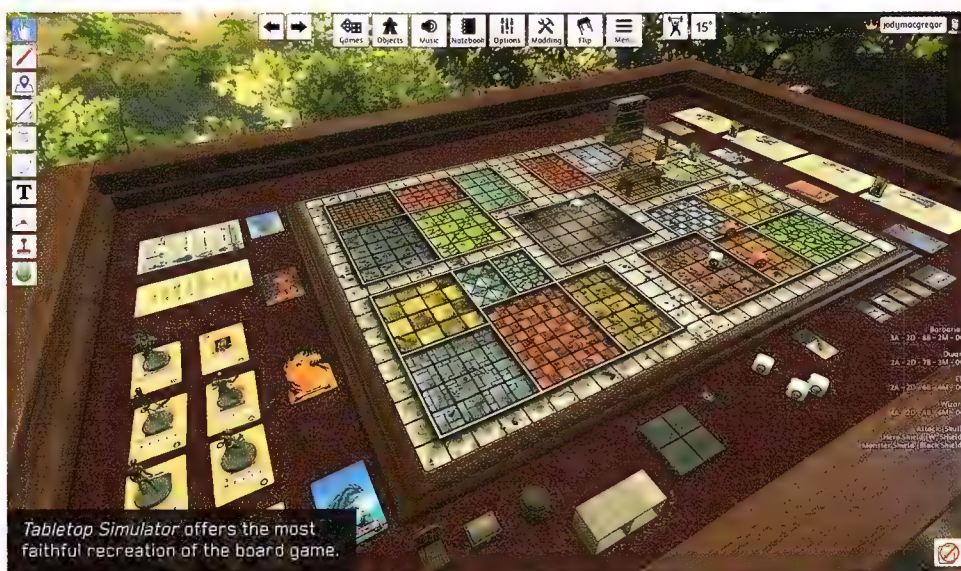
Table talk

What was great about the board game was that it came with such an excellent set of dungeon furniture and miniatures. That manic, grinning goblin is still the first thing I think of when goblins show up as level-one enemies in any game. The

one-eyed fimir, right out of *Warhammer*, looked like a Ray Harryhausen monster. I still have a bunch of the plastic skeletons and mummies, which later became the core of an undead team in tabletop fantasy sports game *Blood Bowl*. The cards were lovely too, with their dopey, overconfident adventurers who've just cast Rock Skin or swigged a potion of strength.

Once you sat down to play it the game was really nothing special. Sometimes you'd roll to move and have one of those turns where you can't get anywhere and just have to say, "I search for secret doors and traps," and the Evil Wizard player would look at the map and say, "There are no secret doors or traps here." (*HeroQuest* was one of those games where, as the kid who owned it and knew the rules, you'd have to be the bad guy and never get to actually play one of those rad heroes on the cover.) Some of the

"HeroQuest was one of those games where, as the kid who owned it and knew the rules, you'd have to be the bad guy and never get to actually play one of those rad heroes on the cover."



quests were a bit rubbish too, like the one where every door randomly teleported you to a different room. Honestly, to hell with that.

Gremlin Interactive's 1991 videogame version keeps all of the worst things about *HeroQuest* and adds a few more. It has fewer equipment cards, so your wizard can't buy a cloak of protection, and the AI is so daft it won't even follow you to another screen.

Those screens are tiny, only depicting one room or hallway – sometimes just a dinky three squares of dungeon. If one of the other heroes is standing on the edge of a transition between screens, finding the spot to click so you can move past them is a huge hassle. There are a lot of traffic jams.

The characters look ridiculous too, the barbarian a muscular toddler who waddles about like his diapers are full. The Amiga version was animated better but had fewer colours to work with, everything sprayed lurid purple like a psychedellic grape juice explosion. And that music I like so much? You can only have it or the sound

ON A ROLL

Classic GW tabletop games available in digital form



TALISMAN: DIGITAL EDITION

An adaptation of Games Workshop's other classic RPG board game – though based on Fantasy Flight Games' 2000s reboot, rather than the 1983 version.



CHAINSAW WARRIOR

I'm not sure anyone was actually crying out for a digital version of this 1987 post-apocalyptic solo board game, but here we are. It's even got a sequel.



WARHAMMER COMBAT CARDS

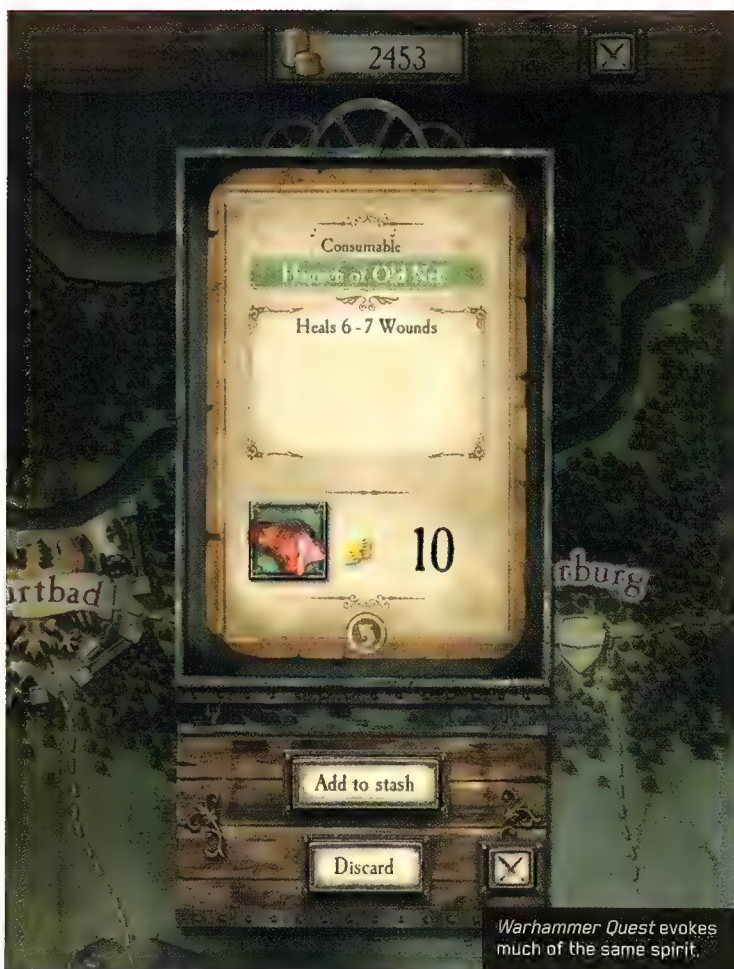
The 1980s card battler was barely more than Top Trumps with photos of miniatures on the cards, but it too has enjoyed new life as a phone game.

effects on, not both at once.

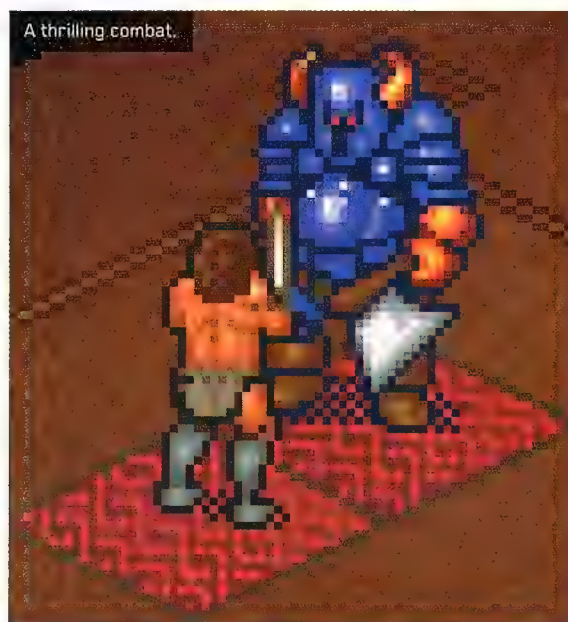
Every quest ends the same way, with a march across the map to get to the stairs and out. All the monsters are dead, all the rooms have been searched, but Johnny Barbarian Hero here wandered off to explore the far corner of the map and now has to spend several minutes rolling-and-moving his way to the exit. The wanker.

I had forgotten about this until

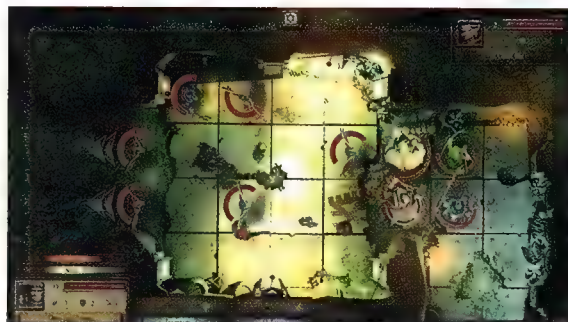
now, but back when I was playing the board game with my friends I'd let them finish the quest and collect their rewards without having to walk all the way back to the exit because that's boring. I took that spirit of ignoring the rules when they got in the way of the fun with me when I started running RPGs like *Warhammer Fantasy Role-Play* for that same group of friends. So thanks for



Warhammer Quest evokes much of the same spirit.



A thrilling combat.



that, *HeroQuest*.

When I was 12 years old the weaknesses of *HeroQuest* didn't bother me much and honestly they're minor annoyances now. I still manage to have a good time with it because all I want to do is roll dice and cast Fire of Wrath and use my broadsword. It's admirably simple, letting you play any quest in any order, with an old-fashioned belief you can be relied on to find your own way through rather than having to be guided by unlocks, and there's no levelling-up to

worry about. You don't have to kill every monster for the experience points because there aren't any, and can just walk past if you can't be bothered fighting them. Jog on, Mr Chaos Warrior, I've got a Talisman of Lore to find.

The other thing to note about *HeroQuest* is that it's very clearly designed for hotseat multiplayer, up to four kids sharing a keyboard and mouse with the Evil Wizard automated. It existed to let children like me be the elf for once, and that's all it had to do.

VILLAINQUEST

The best of the bad guys



SKELETON

The Grim Reaper, but nude.



FIMIR

He works out. Also has a tail.



GOBLIN

Just an ugly face on a tiny body.

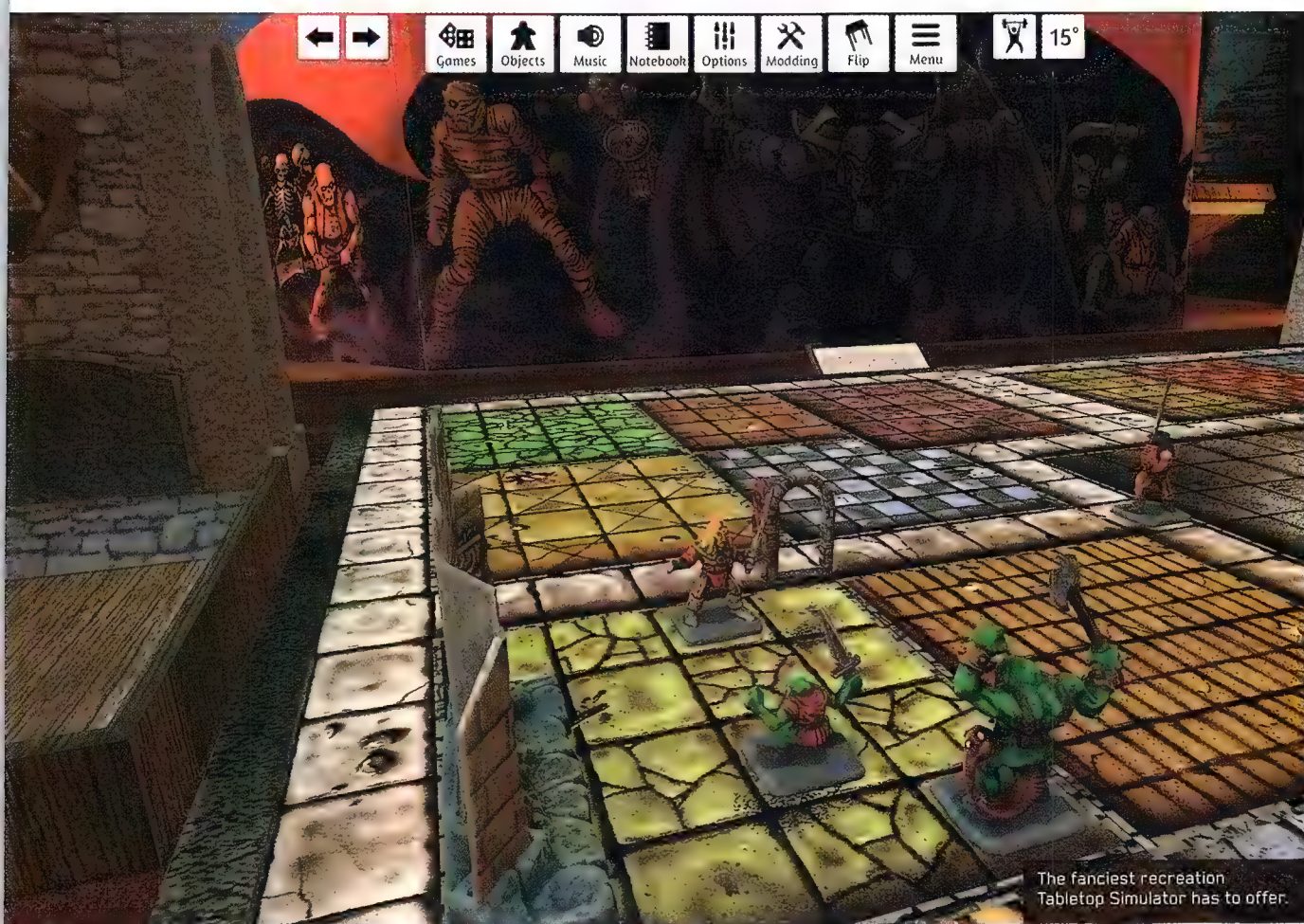


GARGOYLE

Rarely seen but tough as nails.

For a full modern digital *HeroQuest* experience you can play online there's *Tabletop Simulator*, which has at least two implementations in the Steam Workshop, one a fancy version full of accurate 3D models for playing pieces and a fantasy tavern backdrop. The other one is a little more basic, though with animated monsters borrowed from another mod and a forest setting for an outdoor board game vibe. Neither's what I actually want, of course. What I want is to be able to play by myself but with slightly more modern controls than a game that's from 1991.

I turn to Lurchbrik's *Isometric HeroQuest* next, an extremely competent fan game available for free, which should be perfect for me. But it's based on the American version of the board game, which has slightly different rules, and 3D models that don't look like the actual heroes and monsters. It's just different enough to the game I grew up with that it doesn't set off those pleasant memories, while the much more flawed official version from 1991 still does. What a



ridiculous emotion nostalgia is.

Fortunately, there's yet another option. The *HeroQuest* board game was followed by *Advanced HeroQuest*, and then a whole line of *Warhammer Quest* games. The videogame version of the first *Warhammer Quest*, made by Rodeo Games and released in 2015, is thoroughly decent. It gives me four heroes exploring dungeons in a turn-based fashion like I want, but with combat that's a bit more tactical than a board game for nine-year-olds.

Warhammer time

Most fights in *Warhammer Quest* involve my ogre and warrior-priest blocking a doorway while the wizard and elf shoot over them. If you start a turn base-to-base with an enemy there's a chance you'll be pinned in place, so you can rarely rely on mobility to get you out of a jam and have to play defensively, though there's always a chance an ambush will strike at your back line. I give the elf a magic sword and the wizard a stockpile of scrolls to burn through in case goblins launch a surprise attack

at their backs.

Between dungeons everyone marches to the next town, each of which assembles itself out of digital papercraft in a nod to its cardboard roots, and also a bit like the *Game of Thrones* credits. Each rundown hovel presents a new quest in choose-your-own-adventure style. Here in Wurtbad the starving locals want me to bring back their only mule, Old Nell, who was dragged off by a giant spider. I rescue her, turning down an option to waste time grabbing fancy tapestries from the spider's lair because Old Nell might get snacked on while I faff about.

The villagers are grateful, because it's almost festival time and they were out of animals for the feast. I rescued their favourite mule just so they could eat her. But then I'm offered two of Old Nell's haunches as a reward, which turn out to be solid healing items. So I guess we're going to eat her now as well.

These grimy low-rent stories do remind me of something I liked about *HeroQuest*. It promised "high adventure in a world of magic" but then you'd get treasure cards

explaining you found a few coins in a smelly old jerkin, or a single small gem hidden in the toe of a boot. Sometimes you'd find nothing at all, complete with an illustration of a broken-down goober of an adventurer holding out empty hands. The Castle of Mystery, the quest with the teleporting doors, rewarded you with a chest full of gold only to reveal at the end it was fool's gold, completely worthless. In fact so was every bit of gold you found in that dungeon – even the coins in the smelly old jerkin. Pah!

Low-rent heroes scrambling for crap rewards in dirty dungeons, not even earning enough to buy that crossbow they've got their eye on. That's what these games are really about. There are rats on the furniture and the monsters are all slightly more menacing than they need to be for ages nine and up. That's what lingers about the experience of playing *HeroQuest* in either form – the idea that there's less glamour in heroism than you've been led to expect, and that sometimes you have suck it up and be the player who searches for secret doors and traps. ■



Explore

Settings

← Thread



Dana Simmons
@DanaJSimmons

Algorithm update. He cracked it: Two full sentences, followed by a word salad of all possibly applicable keywords. 100% on every assignment. Students on @EdgenuityInc, there's your ticket. He went from an F to an A+ without learning a thing.

1:21 pm · 2 Sep 2020 · Twitter for Android

1.2K Retweets 274 Quote Tweets 3.9K Likes



Students tricked AI marker into perfect results

Online AI marking tool Edgenuity is vulnerable to cunning students.

After receiving a mark immediately after submitting a history paper online, US elementary student Lazare Simmons realised that his paper was being marked by an algorithm rather than his teacher. With the help of his mother, a history professor, the two used subsequent tests to work out that the algorithm gave marks for target keywords rather than coherent short-answer explanations. This meant that full marks could be achieved for simply including a jumbled list of potentially relevant key words at the end of a response. The online education company Edgenuity didn't comment on how it grades students, but clearly it's got some work to do to keep students from gaming its marking criteria.

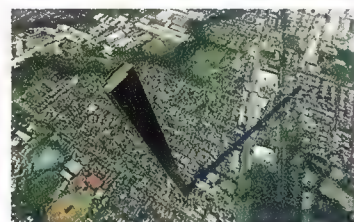
"With the help of his mother, a history professor, the two used subsequent tests to work out that the algorithm gave marks for target keywords rather than coherent short-answer explanations."



Pilots report guy in jetpack doing LAX flybys

Unauthorised jetpack user hovering around LA passenger jet runway.

The airspace around airports is generally pretty controlled in order to maintain safety, but on August 30th planes landing at LAX had an unexpected wingman... a guy in a jetpack. The unusual flying object was first sighted by pilots on American Airlines Flight 1997 who alerted the control tower that they just passed "a guy in a jetpack... Off the left side, maybe 300 yards or so." Not long after the rocketeer was confirmed by a Skywest pilot, with subsequent planes told to keep an eye out for the rogue speed demon.



OpenStreetMap error creates 212 story tower in Flight Sim 2020

A typo in the OpenStreetMap data made by a university student working on a project was picked up by Microsoft's latest *Flight Simulator 2020* game and modeled into a ridiculous looking cityscape. The Fawkner building was allocated 212 stories instead of 2, and while the mistake has since been corrected the devs used the OpenStreetMap info to build the game's terrestrial information before it was rectified. This ridiculously out of place building has become one of the most visited wonders of *Flight Simulator* alongside controversial locations like Jeffrey Epstein's private island.



Canadian police using predictive policing algorithms

A report by the University of Toronto's International Human Rights Program and Citizen Lab has revealed that Canada's law enforcement agencies are using a variety of algorithmic policing methods. In addition to using historical data to predict potential locations of criminal activity, the state's police forces are using predictive algorithms to identify potential missing persons and people that are 'at risk' of committing crimes. The report highlights a number of potential issues with the mass collection of public data like social media content and facial recognition and co-author and criminal defense lawyer, Kate Robertson, said disadvantaged communities are at greater risk of targeted surveillance. ■

Wave:3 is a premium microphone and digital mixing solution that fuses plug and play convenience with broadcast-grade circuitry.

elgato.com/wave-3

PREMIUM MICROPHONE & DIGITAL MIXING SOLUTION

WAVE:3



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Every feature you need

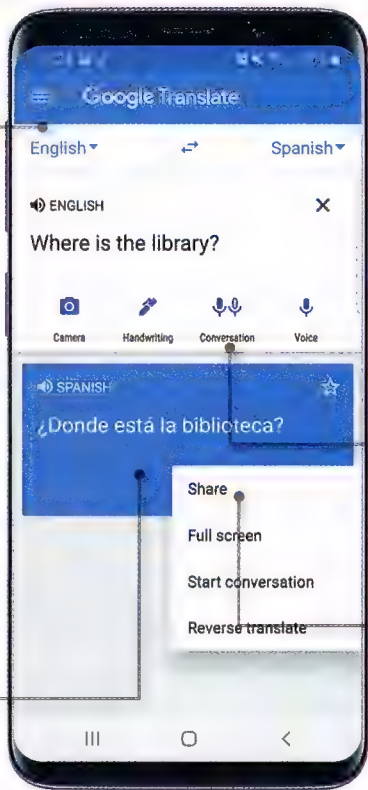
A simplistic translation screen

TRANSLATE EVERYWHERE

You can translate any sentence into any language and then share it with Messaging and many other apps and services to converse immediately in two languages.

REAL-TIME

When you type in text or speak into the microphone, the app will immediately translate your words into the chosen language. It all happens in seconds.



SO MANY FEATURES

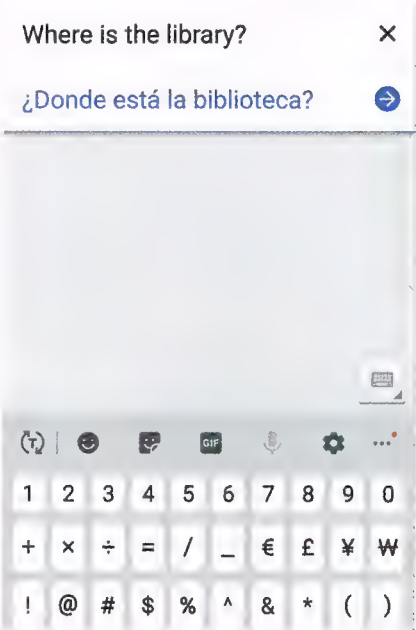
There are many other features available in Google Translate, including dictionaries, your translation history, favourites and the ability to read foreign scripts. If you take some time to understand everything the app does, you will be rewarded with a solution that will come in handy time and time again. It is a brilliantly simple and at the same time very clever solution.

TIME TO SPEAK

The conversation mode lets you talk to anyone who speaks a different language in real-time. This is particularly useful when on holiday in a foreign country.

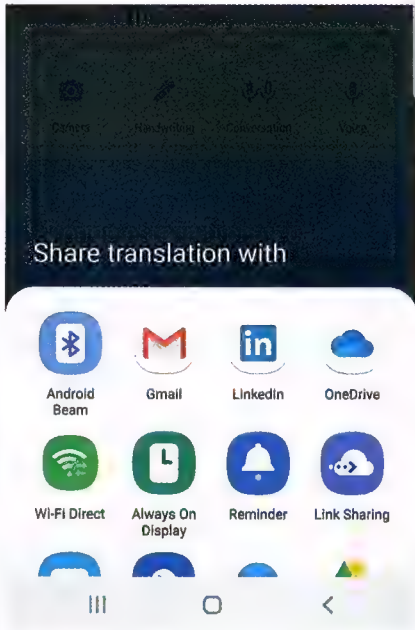
SHARE TRANSLATIONS

Any translated text can be shared via a wide range of services by tapping the menu icon and choosing the Share option from the pop-up menu.



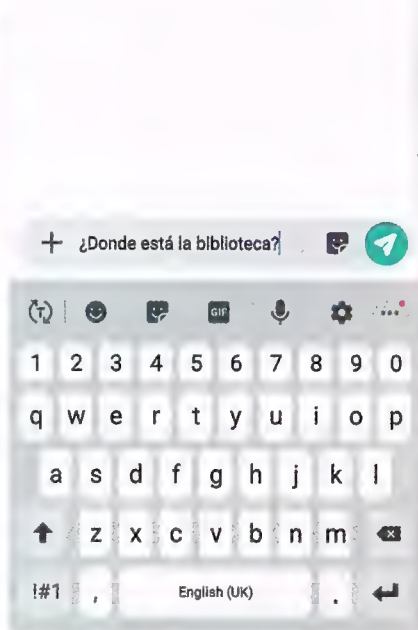
04 TEXT AS WELL

If the app struggles to understand you, tap the back button and type your message instead. This will work almost 100 percent of the time and is much more accurate, if a little time-consuming. The text will translate as you type.



05 SHARE THE TRANSLATIONS

In the Translate mode, you can type in or speak any phrase and translate it into different languages. There is a Share option that is accessible via the menu icon; tap this to share the text with other services.



06 TRANSLATED TEXTS

You can share any translation you create with Messaging and also translate received messages in another language using the app. Your entire text-message conversation can be undertaken easily in both languages.

Converse with anyone, in any language

Use Google Translate to speak to anyone in more than 100 different languages.

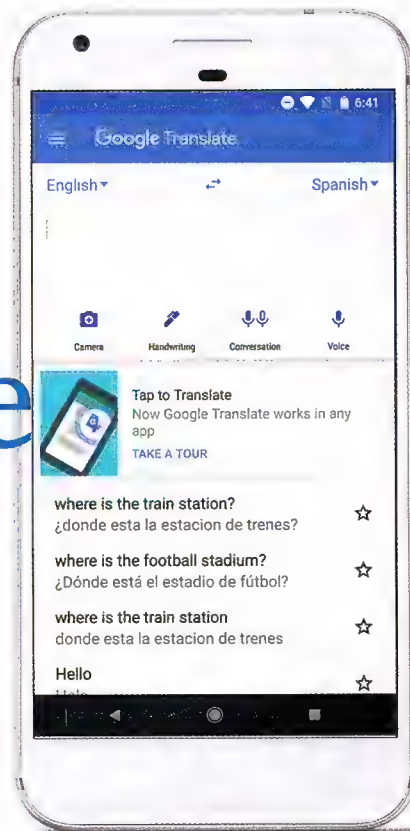
You may think that you will rarely require the ability to translate a foreign language and text, but that could be down to the fact that you may believe it to be difficult and time-consuming. With Google Translate, however, you now have more than 100 languages at your fingertips and you can use the immediate translations in a variety of ways.

The conversation mode lets you pass your phone between two people and to hear the translations spoken out loud while you are speaking. This is ideal when exploring a foreign land on holiday, enabling you to interact and

converse with the local residents almost as seamlessly as if you were fluent in their language.

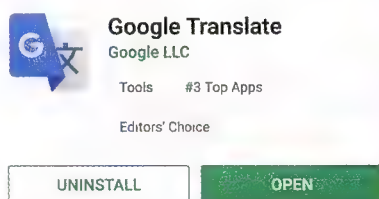
The translate mode offers the simplicity of either typing or speaking a phrase and seeing it translated immediately, but it is the ability to share the translations with so many apps that makes it a very powerful tool for texting and communicating with people. There is a phrasebook, the ability to save often used phrases and a host of other hidden features which only come into play when you need them, and together they create something very special.

When you consider just how



useful this solution can be and how accurately it works, you will have the ability to converse with people in real-time in a way that you may previously have not thought possible. It is a hidden jewel in Google's crown.

TRANSLATE | SPEAK TO THE WORLD



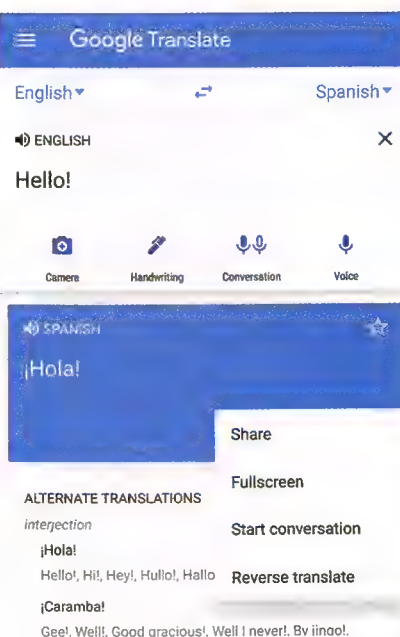
What's new
Last updated 2 Aug 2019
Improved offline translations with upgraded language downloads

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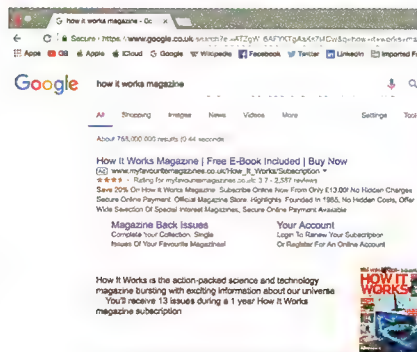


01 GRAB THE APP
Download the Google Translate app from the Google Play store and install. It requires quite a few permissions to work properly, but this is expected for the huge amount of functionality that it offers.

02 START A CONVERSATION
Start off by selecting the language you are translating from and the language you are translating to, then enter some text to translate. When the translation appears, tap the menu icon on that box and choose 'Start conversation'.

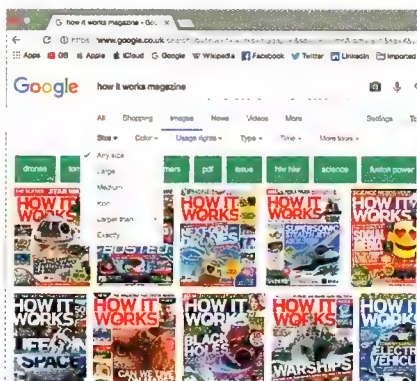
03 START TO TALK
Each of you can now press the language buttons at the bottom before you speak and the audible translations will be sounded after each sentence. They are also presented as text on the screen, so you can see what's being said.

SEARCH | USE ADVANCED TOOLS TO SEARCH.



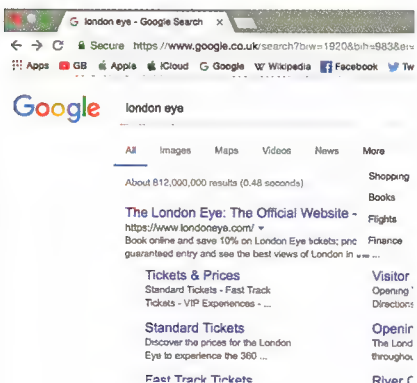
01 FIND THE OPTION

When you complete a search in Google you will be presented with a standard list of weblinks, some of which contain further page links. Notice the row of options at the top.



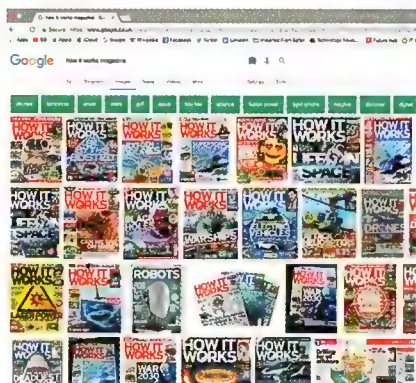
04 SIZES AND COLOURS

You can also click the 'tools' option and then choose what size image you need, a choice of colour and even the time it was published. This feature offers very specific searching.



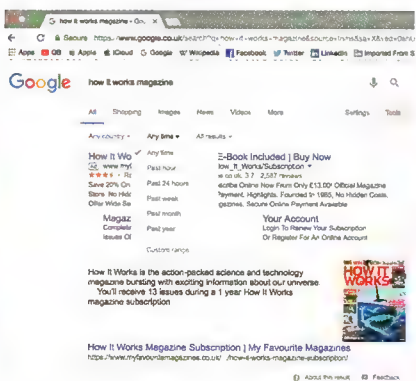
07 THERE'S ALWAYS MORE

The More option offers a method of narrowing down the results to blogs, news, videos and many other categories. This will help you find exactly what you need in a couple of clicks.



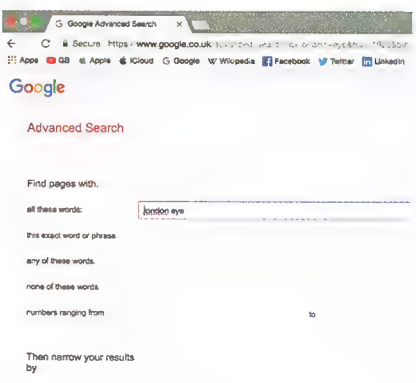
02 IMAGE SEARCHING

Click the Images option to be presented with a grid of related images. These are laid out in the most relevant order and not narrowed down in any way, but they can be.



05 DEFINE PAGES

When in the standard Google Search view, click 'Search tools' again to choose locations, an exact time frame or only pages from your own country. You can even specify non-visited pages.



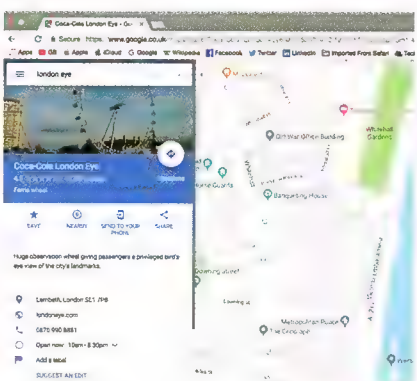
08 EVEN MORE ADVANCED

Tap the cog on the right-hand side of the page and you will see an 'Advanced search' option. Click it and take some time to check out all of the boxes on this particular page.



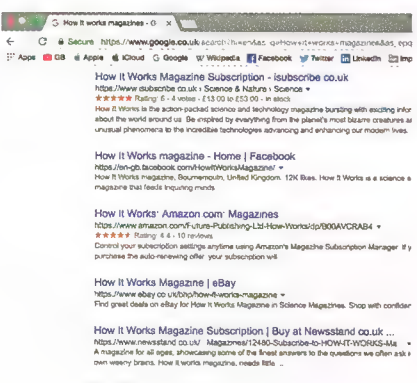
03 DETAILED IMAGE INFORMATION

Click on any image to see it expand and to view information about it. The size, a link to the original page and similar images are also shown. You can right-click to copy it.



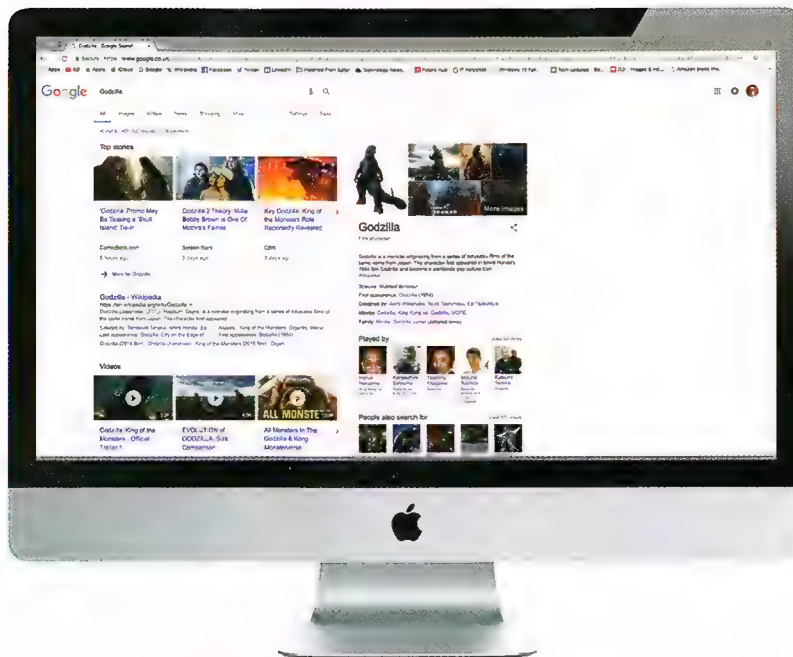
06 WORDS AND MAPS

Clicking Maps will immediately present a Google Map showing the location of your search result. Multiple results will be listed on the left-hand side and one more click will present a new map.



09 EXTREMELY SPECIFIC RESULTS

Once you have entered the exact parameters you are looking for, a standard search page will appear. Expect to receive no results on occasion, but it can be extremely accurate.



GOOGLE TIPS

Search more accurately using the advanced tools

Specify exactly what you need to find and narrow down your results by using advanced search tools.

Most people use Google Search every day and accept the results that are presented. This is perfectly reasonable because the results are almost always accurate and fit the search term that has been inputted, but there are ways to improve your results.

Google offers many tools that will let you search for images, locations and other non-text references with ease and even

these can be expanded upon to let you find exact image sizes and the type of images you require. The Advanced Search option lets you specify more than one term and you can choose what to include and what to avoid, which should bring results that are as near to your requirements as possible. The simplistic search page also lets you compare the prices of products, find books and apps, and jump to

Google Maps if you need a particular location.

For most tasks you will not need these tools, but for research and more serious undertakings they offer a lot of benefits and time savings which should prove useful to you. If you use the search tools wisely, you will have the ability to find anything in seconds, despite the fact that the internet is an immeasurably large place.

Search layout

Lots of tools in one place.

POWERFUL IMAGE SEARCHING

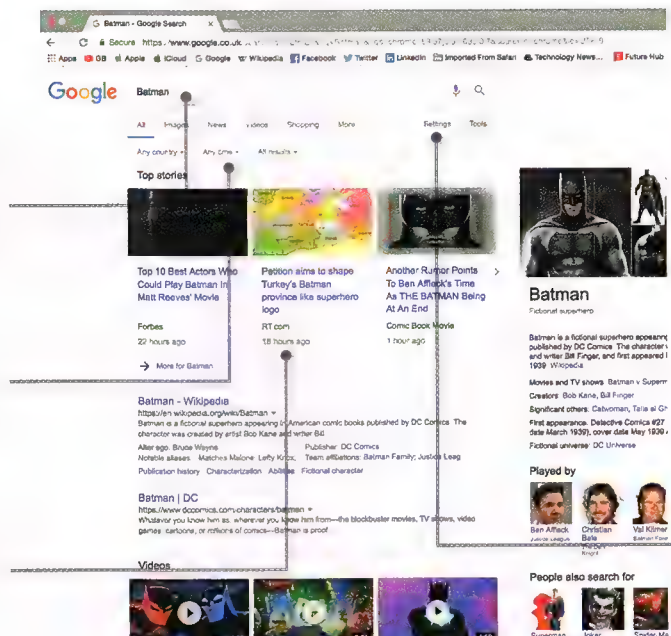
Image searching can be very precise. You can choose colours, exact sizes or even the style, such as faces or drawings.

TYPES OF RESULT

You can also specify where you want to get your results from. Blogs, discussions, patents and news sites are available.

LOCATIONS AND TIMES

Narrow down results by choosing when and where they are. Click 'Search tools' to bring up this row of powerful options.



SAFESEARCH

Google Search is designed to offer all of the results possible, but there will be times when you need to limit them. SafeSearch is available via the cog on the right-hand side of the search page and will filter out adult content from your results. It cannot do this 100 per cent of the time, but is useful if you let your children use Google.

ADVANCED SEARCHING

Exact phrases, languages, reading levels and where terms appear on a page can be selected in the advanced search option.

Start labelling emails

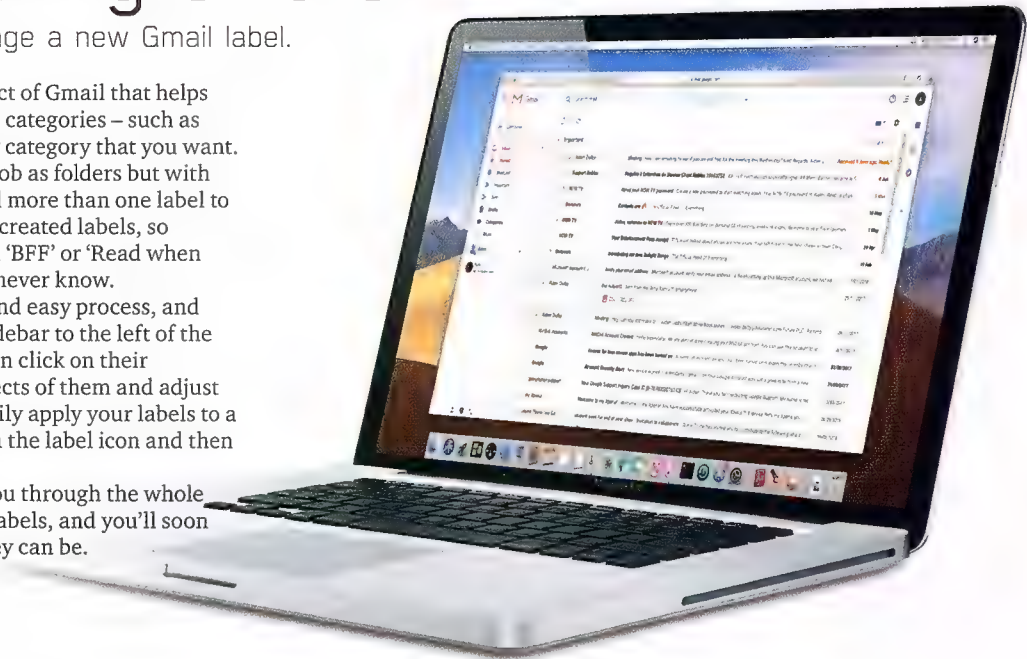
How to create and manage a new Gmail label.

The labels feature is a useful aspect of Gmail that helps you to organise your message into categories – such as work, family, sport, school, or any category that you want.

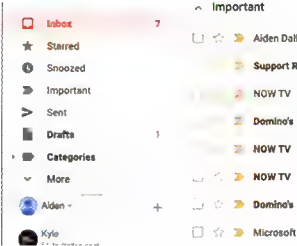
Essentially, labels do the same job as folders but with one major advantage: you can add more than one label to a message. Only you can see your created labels, so whether you mark a message with 'BFF' or 'Read when hell freezes over', the sender will never know.

Creating new labels is a quick and easy process, and once created they will sit in the sidebar to the left of the Gmail interface. From here you can click on their drop-down arrows to change aspects of them and adjust the settings, and then you can easily apply your labels to a message by opening it, clicking on the label icon and then selecting your new label.

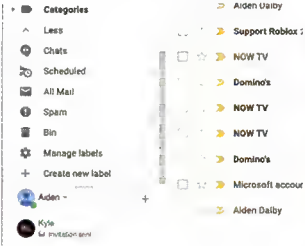
In this tutorial, we will guide you through the whole process of creating and applying labels, and you'll soon come to appreciate how useful they can be.



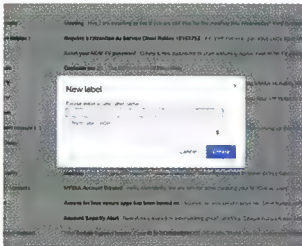
GMAIL | CREATE AND APPLY LABELS



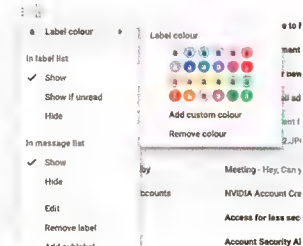
01 **CLICK ON 'MORE'**
In your main Gmail interface, look at the column on the left-hand side and then scroll down to click on the 'More' option at the bottom.



02 **CREATE NEW LABEL**
Now scroll down further and click on the 'Create new label' option right at the bottom of the list. Drag the grey divider down if it is in the way.

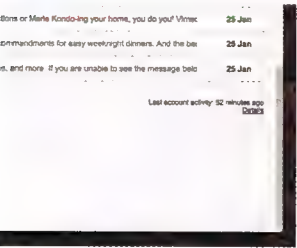


03 **NAME LABEL**
You will now be invited to enter a name for your label and determine where it will reside in the menu. Once done, click on 'Create'.

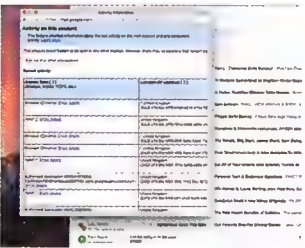


04 **MANAGE LABEL**
You can now click on your label in the menu and customise it. You can add emails to the label by clicking the label icon while reading through one.

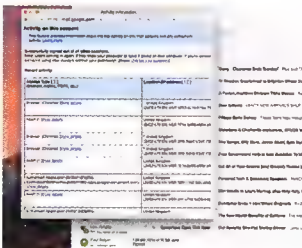
GMAIL | SIGN OUT REMOTELY



01 **CLICK ON 'DETAILS'**
If you forget to sign out of Gmail on another computer, you can do it remotely. Scroll down to the bottom of your inbox and click 'Details'.



02 **MONITOR ACTIVITY**
All of your account activity will be shown in a list, so you can see when and where you have logged in and see if previous sessions are still open.



03 **SIGN OUT**
At the top of the window you will see the option to 'Sign out all other sessions'. Click on this and a message will confirm that you have signed out.



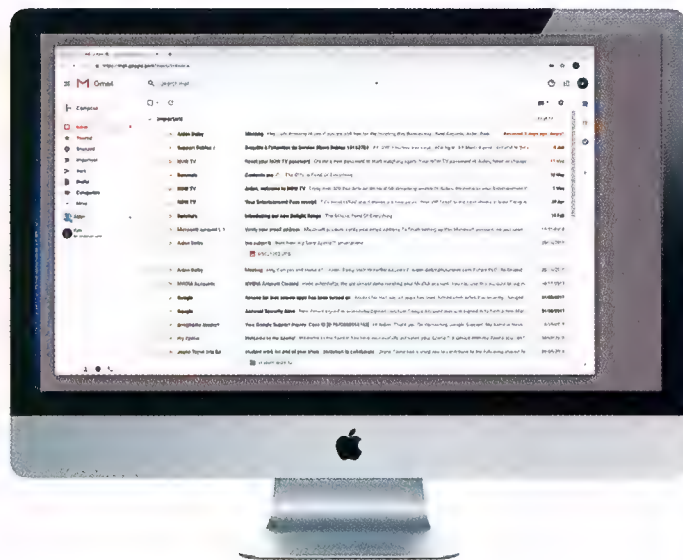
04 **CHANGE PASSWORD**
If you are worried that your password may have been stored on that other computer, head to Settings > Accounts and then click 'Change password'.



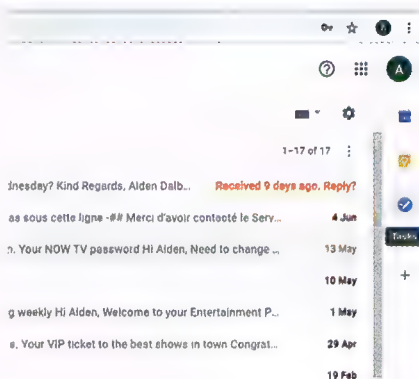
Save reminders and to-do lists

Give yourself a visual heads-up through Gmail.

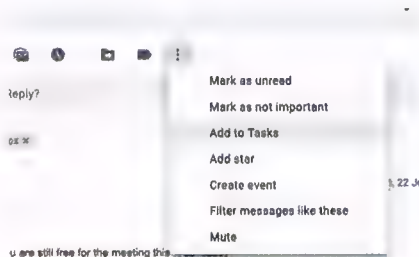
Google Tasks is a lesser-known feature of Gmail that can prove to be an incredibly useful to-do list. With Tasks you can just click and type to add new tasks, set due dates or add notes, and then tick each task off as you complete it. Your task list stays up to date no matter how you access it (which you can do via other Google services such as Calendar and through your mobile device's Gmail app), and it's always with you wherever you go. When used through your desktop computer via Gmail, Tasks will be displayed in an ever-present window in the corner of your inbox, so you can easily add emails as tasks – for instance, if there is an email you need to respond to and you want to be reminded later on.



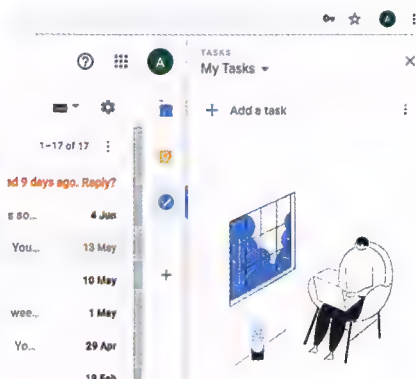
GMAIL | STORE YOUR NOTES WITH TASKS



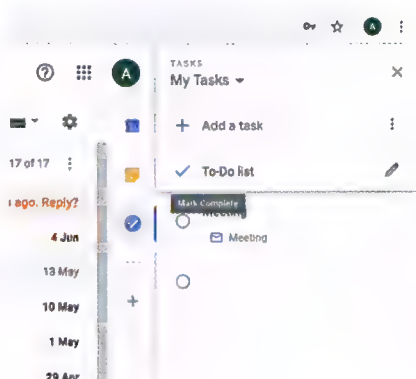
01 Click on the 'Tasks' menu in the top-right corner of the Gmail interface and then a task window will now appear in the right side of the interface. It will take up about a fifth of the screen space.



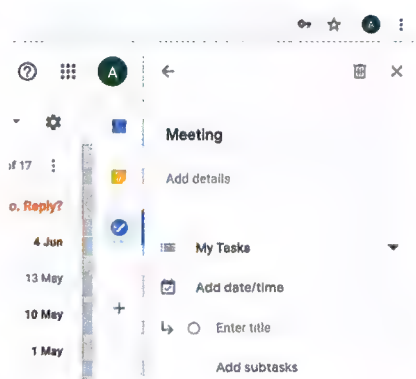
04 You can also convert emails into tasks on your list. To do this, open up an email message from your inbox and then click on the More menu at the top of the screen. Now simply choose 'Add to Tasks'.



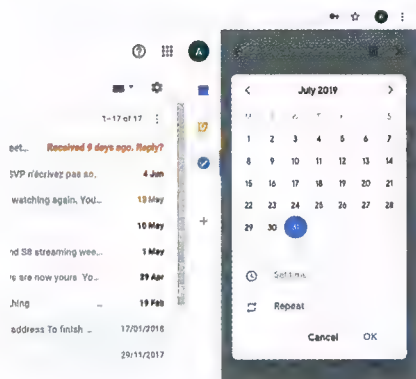
02 Use the tasks window to create simple to-do lists. Click on '+' to create a new item and then give the task a name. Click on the Pencil icon to go into more detail.



05 Click on the circle next to a task and it will be removed and added to the 'Completed' folder. You can also delete tasks by going into the task details and clicking the bin icon.



03 Click where it says 'Add details' and type any information relating to the task. You can also add Subtasks if you wish as well as put the tasks into categories from this menu.



06 To set yourself reminders to complete certain tasks in your list, click on a task, then the calendar icon and set the due date and time. It will then be marked on your Google Calendar.

Hang out on Google

Hook up with your friends for face-to-face online chats.

Google's product portfolio is packed full of services to help you communicate with others – be it via email through Google's Gmail service, via videos uploaded to your YouTube channel or via text messages through Chat. Also accessible through Google is the Hangouts service. This allows you to instantly hook up with people from your social circles using your computer's webcam and chat in real-time, which is the next best thing to meeting up in person.

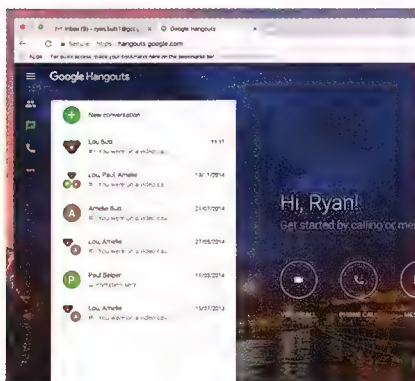
Hangouts is an ever-present feature of Google and can be accessed by clicking on the Hangouts icon in the top-right

corner of the interface. Here you can choose to create a new Hangout, hook up with people you have hung out with previously by selecting them from the list, or you can make yourself available to meet up should any of your friends be online.

In this tutorial, we'll guide you through the process of starting your own Hangout. The more you use the service, the more natural a means of communication it will become, and before too long you'll be hosting your own online parties and ping-pong off quick-fire messages.

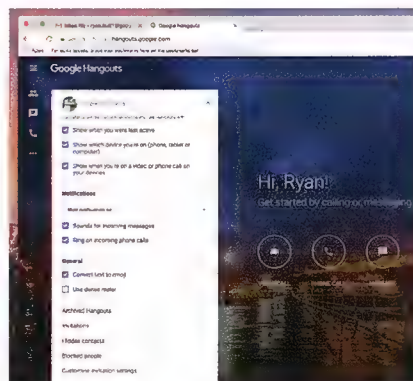


HANGOUTS | START AN OPEN HANGOUT



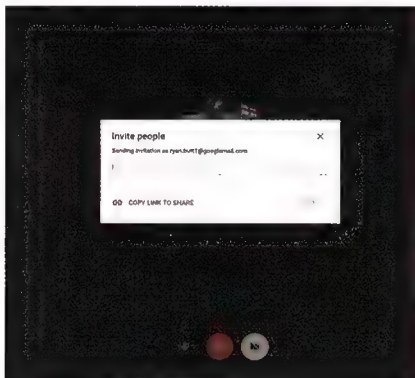
01 GO TO HANGOUTS

Click on the grid icon in the top-right corner of the Google interface and then choose Hangouts. Once loaded all of the tools you need to text, call and video conference people will be available.



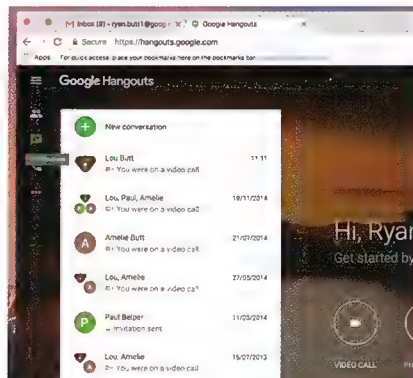
02 EXPLORE THE OPTIONS

Click on the '...' icon in the left column and then choose the Settings option. You will now be able to set notifications and set your status to let others know you are available to chat.



03 POST AN INVITATION

Click on the Video Call icon to initiate a chat. You will then be able to invite people to your Hangout by entering names or phone numbers into the space provided.

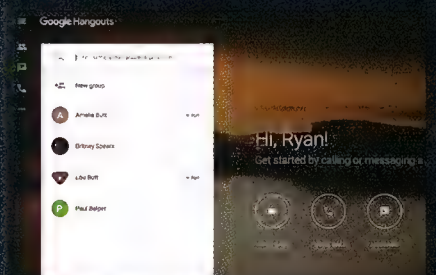


04 QUICK HOOKUP

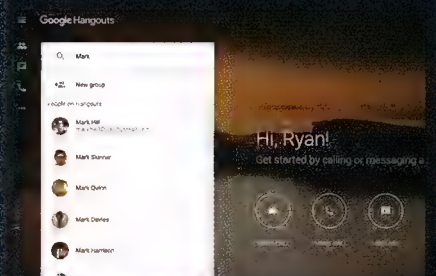
All of your previous Hangouts will be listed in the Hangouts column on the left, so you can hook up with the same bunch of people again quickly and easily by just clicking on them in the list.

Finding people to join you in a Hangout

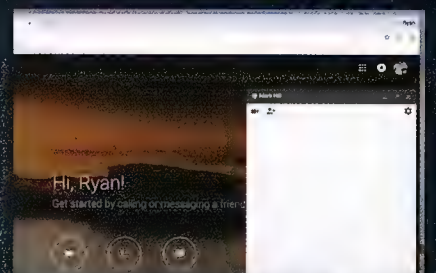
Here's how to add people and Circles to your Hangout.



01 Click on New conversation at the top of the Hangouts column and all of your current Google+ circles will be listed. Tick a box and you can start a text or video chat.



02 In the box at the top of the Hangouts menu, start typing in names. Google+ will match them with other people on Google+, even if they aren't in your circles.



03 Click on the box beside a person's name and you will add them to your Hangout. You can either send them a text message or invite them to a video chat.

GOOGLE TIPS

Communication

Google's services make it easy to communicate online, so let's dive in and explore them in depth.

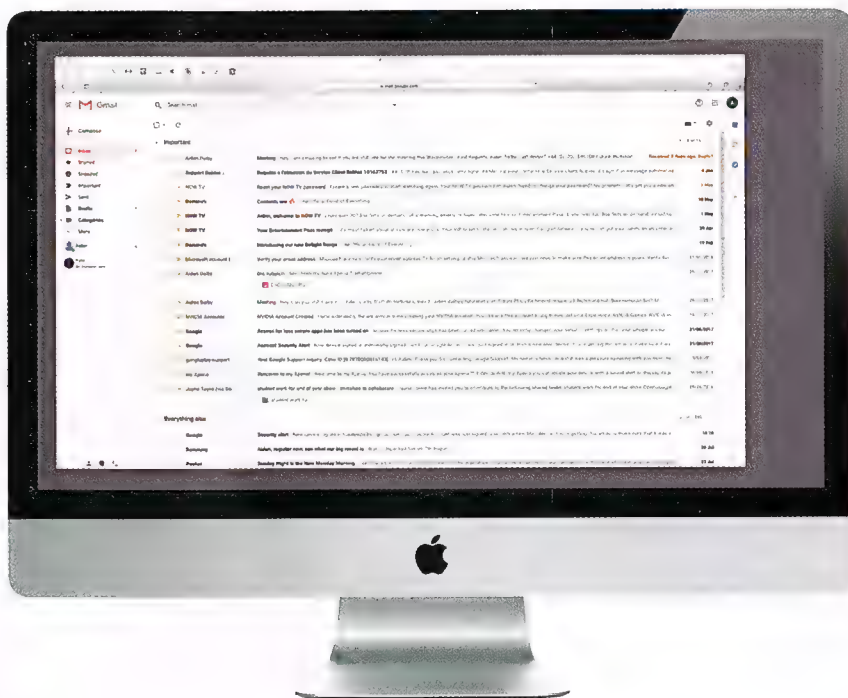
Getting organised with Google's huge array of web, mobile and tablet apps goes way beyond syncing your emails and calendars and setting up a few bookmarks for your favourite sites. It is now possible to shift your entire life onto Google, utilising its free services to better manage everything from everyday tasks, to the running of your business, and keeping up to date with your stocks. The key is how you implement these tools into your life.

A lot of what's available through Google's web browser, Chrome, is not always hugely advertised. There are a lot of great unknown tricks and tips for speeding up your workflow and streamlining the way you and your devices communicate with Google.

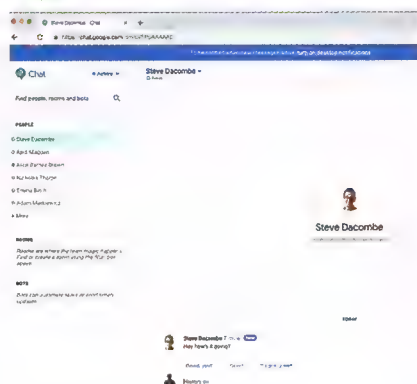
In the following tutorials you will learn how to make the most out of Google Drive; discover how to treat Chrome as your new desktop, giving you access to all your files, documents and favourite websites instantly, as well as a selection of tips on the

various Chrome extensions that are available; and learn some great time-saving techniques for organising all of your online and offline content. Whether you want

to play music from the cloud or receive phone notifications on your desktop, in these guides you are going to find out just how organised you can get.

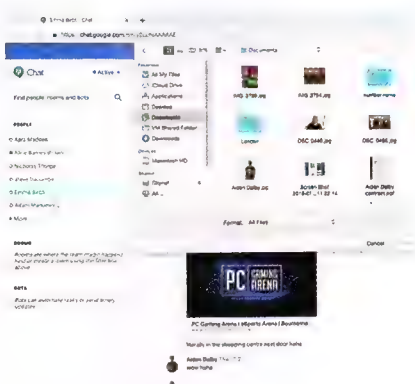


HANGOUTS | COMMUNICATE VIA TEXT MESSAGES



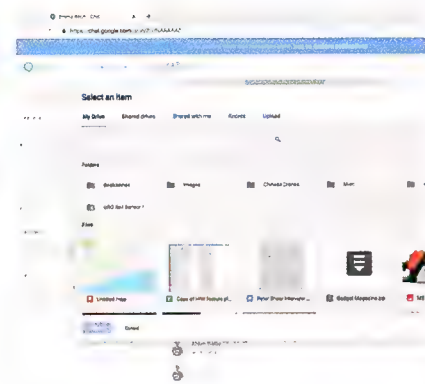
01 YOUR MESSAGES

When you open Chat, all of your conversations will be listed along the left-hand side. New messages will be highlighted as well as online statuses. Those online will have a green circle by their name.



02 UPLOAD PHOTOS OR VIDEOS

Click on the upwards-pointing arrow icon to upload something from your device. Simply find the file, image or video you would like to send and double-click on it.



03 SHARE FROM DRIVE

You can also share content from your Google Drive. Click the Drive icon and use the menus along the top to navigate. Click the item you want to send, then 'Select' and it will be added to your message.

Work with tags in Feedly

Create an article library in Feedly with tags.

Since the discontinuation of Google Reader, Feedly is going to be your new home for all your favourite site and news feeds, compiling the articles you want to read into one tidy space.

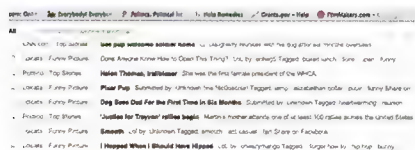
Feedly comes with a fantastic categorising system, which allows you to set up news feeds under specific categories. The only downside of this category system is once you have read an article and want to save it, you can only save it to a single archiving folder, which cannot be categorised or ordered. However, what you can do instead is categorise articles by tags. A tag is a singular descriptive word which is

somehow relevant to the content of an article. Tags are present in almost any kind of news article or blog post. They help categorise an article and give it better reach to the kind of people who are searching for tags specific to that article.

With the Feedly tagging system, you can now add as many tags as you like to an article. Each tag will then become its own category, which you can access through Feedly, creating an incredible vast and specific library of articles that can be accessed in an instance by selecting a tag.

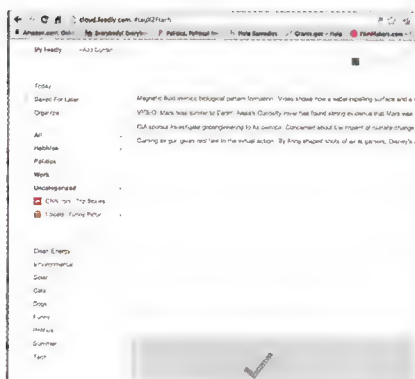


FEEDLY | ORGANISE ARCHIVED ARTICLES WITH TAGS



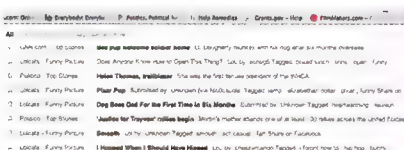
01 ACCESS TAGGING OPTIONS IN FEEDLY

Opening your primary Feedly news feed, click on any article. Then a preview of the article will be shown with a selection of sharing options. Click the '+ Tag' icon to access your tagging options.



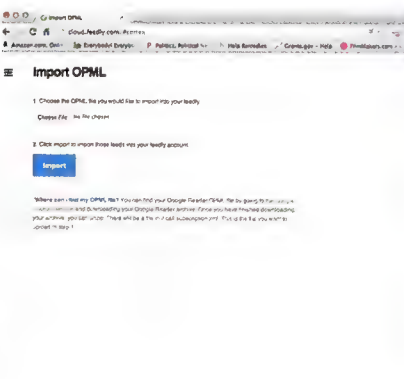
03 FEEDLY TAG CATEGORISATION

Click the menu icon to the top right of the page. Below your Feed categories will be a list of your created tags. Click one to access all articles that have been assigned that tag.



02 ADDING TAGS

From the drop-down menu you can tag an article with pre-existing tags or create a new one. Added tags will appear in green below the article. You can add as many tags as you like.

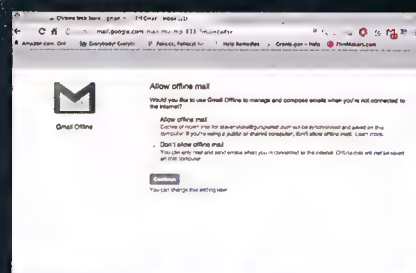


04 IMPORTING TAGS

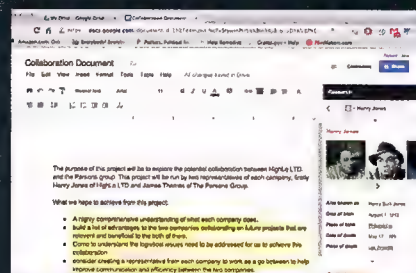
If you were a user of Google Reader, you can import your old tags (if you were using a tagging system) when you import an OPML file.

Harnessing the power of the Omnibox

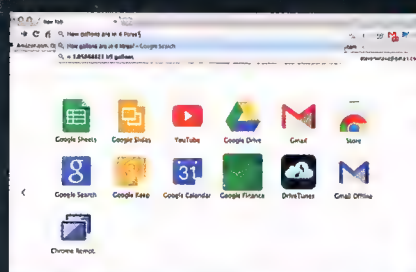
Using Omnibox, Chrome's intuitive address bar.



01 Omnibox can do much more than access websites. If you don't know the name of the site you're after, type in some relevant keywords and let Google find it.



02 You can do equations in Omnibox, using the +, -, * (multiply) and / (divide) icons. Type in an equation for an instant result, then continue with more operations.



03 It can do weight and measurement conversions too. Phrase the conversion in the form of a question using numerals; eg 'How many gallons are in 4 litres?'

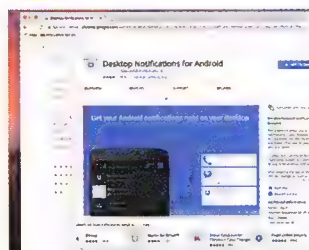
See phone notifications on your desktop

Monitor your Android device activity with Chrome.

If you're finding yourself getting distracted by your phone at work then check out the Chrome Desktop Notifications extension. Sync your Android device's notifications with your Chrome web browser with this Chrome extension and Android app. So whenever you receive a notification for a missed call, for example, on your Android device, it'll be forwarded to Chrome, which will display the push notification in a pop-up window on your desktop, allowing you to screen calls and messages from there. This will also be useful when your device is on silent but you want to monitor its activity. Check out these steps to learn how to install and run the Desktop Notification service. There is currently no such extension for iOS devices, but several other Chrome-to-iOS extensions are available.

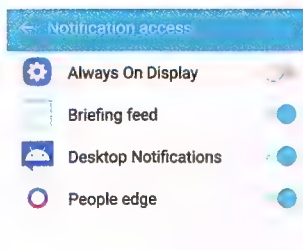


CHROME | FORWARD PHONE NOTIFICATIONS



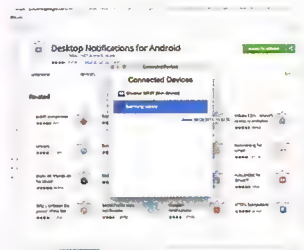
01 DESKTOP NOTIFICATIONS

In the Chrome Web Store, search for Desktop Notifications; add it to Chrome. Search Google Play for the same, installing it onto your device.



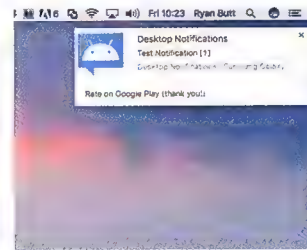
02 THE ANDROID APP

Open the Android app. Tap 'Open Accessibility Settings'. Under '1. Services', ensure Desktop Notifications is set to On. Go back to the app.



03 SYNCING THE DEVICE

Under '3. Connect' note the code. On your desktop, open Chrome. Click the Desktop Notifications widget and input the code. Click 'Apply'.

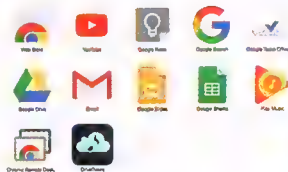


04 TEST NOTIFICATION

On the Android app, under '4. Test' tap 'Create Test Notification'. The notification should appear on your desktop, as will future notifications.

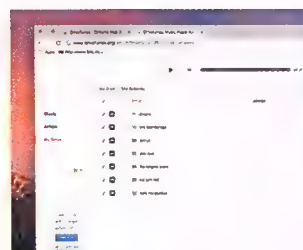


CHROME | PLAY MUSIC THROUGH DRIVETUNES



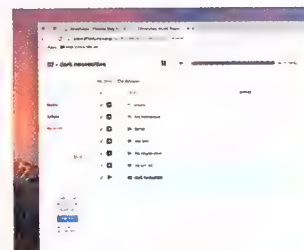
01 ADD DRIVETUNES

Visit the Chrome Web Store, search for DriveTunes, open it and add the extension to Chrome. It will be added to the Chrome splash screen.



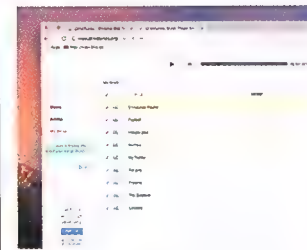
02 RUNNING DRIVETUNES

Open DriveTunes from the splash screen, or visit www.drivetunes.org. All audio files from your Drive folders will be added to DriveTunes.



03 PLAYING YOUR MUSIC

Use the search function to locate audio files, set up shuffle or repeat functionality and browse your new catalogue, all within DriveTunes.



04 PLAYLISTS IN DRIVE

Open Drive, create a folder and add some songs to it. When you open DriveTunes, that folder will appear featuring those selected songs.

Access your computer anywhere

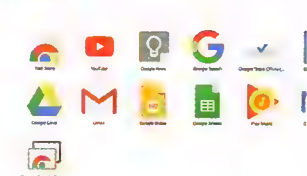
Control your computer remotely through Chrome.

Google created the Drive online storage service to benefit users who wanted to access their files from various computers instantly. The cloud service for Drive is fantastic, and the web apps which allow you to run certain files from it make accessing your files from anywhere simple. As organised as you can be with Drive, it can be

problematic if you find yourself away from your main computer and the files you need to access are not on Drive, or cannot be run on Drive or the computer that you are on. This can especially be the case for files that are specific to certain computer software, which won't run on Drive and may not be installed on the computer, such as

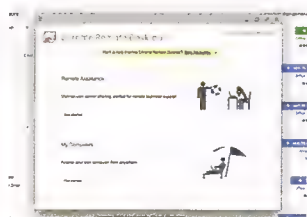
a Photoshop .PSD file. To get round this, using the Chrome Desktop Remote app you can log into and control your main computer from any other computer in the world through Chrome, as if it were right in front of you, providing limitless control. Take a look at our steps to set up your own Remote Desktop service.

CHROME | REMOTELY CONTROL YOUR HOME COMPUTER



01 INSTALL REMOTE DESKTOP

Visit the Chrome App Store, find and add Chrome Remote Desktop. Now open it, agreeing to the permission requests. Under 'My Computers', click 'Get Started'. Click 'Enable Remote Connection's to download the Chrome Remote Desktop Host installer. Begin the installation.



02 CREATING A PIN

Now go back to the Chrome Remote Desktop app in Chrome and enter a secure PIN number, which will be used to gain access to your computer remotely. A preferences panel will open; unlock it if necessary, then input the PIN you just created to enable remote connections.



03 ACCESS YOUR COMPUTER

Log into Chrome on another PC/Mac and repeat steps 1 and 2 so Chrome Remote Desktop is enabled. Under My Computers, the computer you set up first should be visible. Click on it, and input your PIN number, then click Connect. You can now connect to and control the computer remotely.

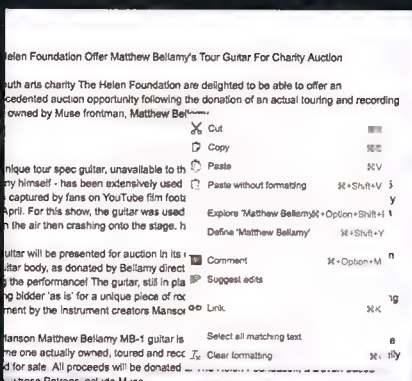


04 SHARE WITH OTHERS

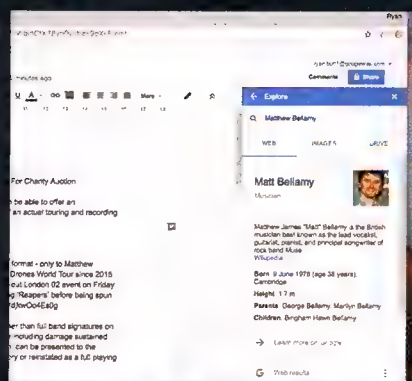
From the Chrome Remote Desktop menu, under 'Remote Assistance' click 'Share'. You will be given an access code that you can give to another Chrome user so they can access your computer: click Access and provide Chrome with a code to access another Chrome user's computer.

Researching with Google

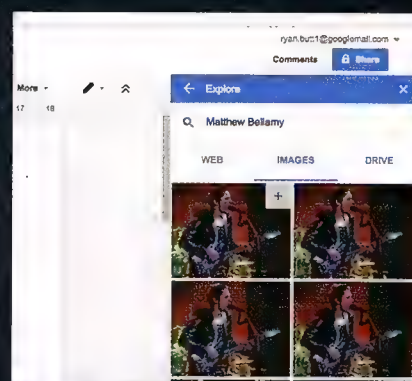
Start researching through Google Docs



01 In a Google Document, highlight a piece of text you'd like to get more information on. Right-click and click 'Explore Highlighted text'. This will open a research pop-up window within Google Docs.



02 Depending on the content of the text you selected, you'll get varying results. At the top of the pop-up will be a summary of the wording as best compiled by Google, followed by web results.

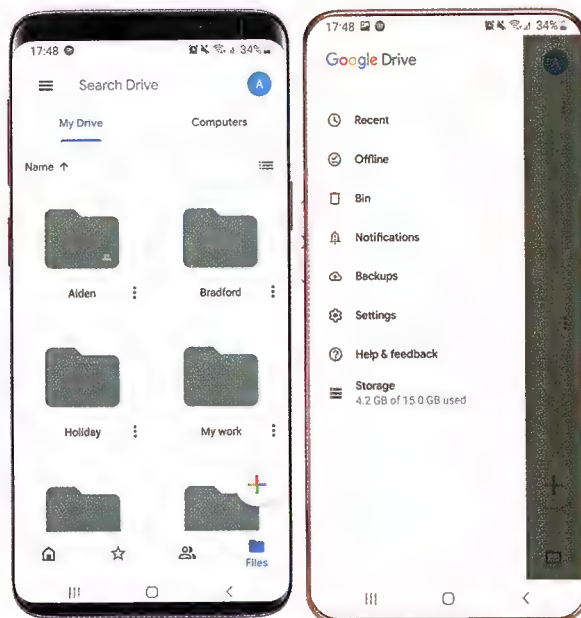


03 Use the tabs at the top of the 'Explore' column to access web info, pictures and any related content from your Google Drive. It's a handy way to access key information quickly to help with any project.

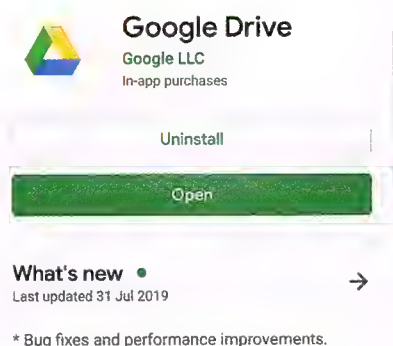
Organise your mobile device with Drive

Stay organised on the go with Drive Mobile.

If you find yourself spending as much time on your smartphone or tablet as you do your computer then maybe it is time to get Google Drive set up on these devices as well. Doing this means no more having to email yourself documents to check over, or being away from your desk, because you will have a virtual one in your hand, as well as being able to edit and share content through Drive. To really get the benefit of Google on a device, download Google Calendars, Gmail, Google Finance and Google Keep to it. In this tutorial you will find out how to set up Drive to make the most of it on the go and prepare files to make them accessible anywhere, any time.

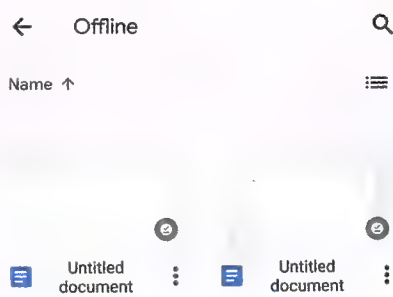


DRIVE | SET UP DRIVE ON YOUR SMARTPHONE



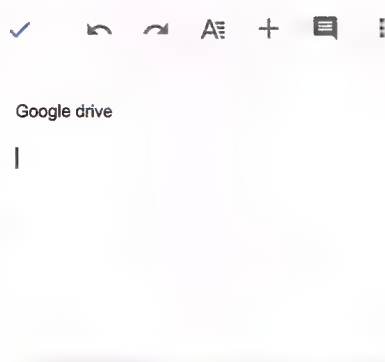
01 DOWNLOAD DRIVE

Visit your device's app store and search for Google Drive (not all devices are compatible). Download the app and sign into your Google account. All your Drive files will be displayed within the app.



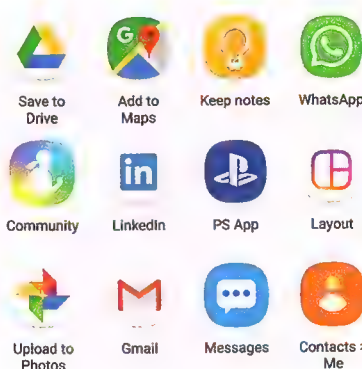
04 ACCESSING OFFLINE FILES

From your Drive list, tap the menu icon, then 'Offline' to display all files that you have been allocated to Offline mode. To remove one from it, tap and hold a file, then tap 'Remove Offline'.



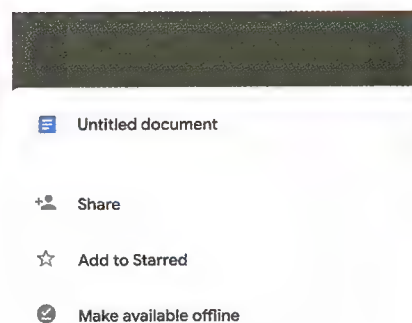
02 WORKING ON A DOCUMENT

Open a Google Documents document. There are no restrictions within the Google Docs mobile app, other than its smaller interface. You can edit a document as you would on a computer.



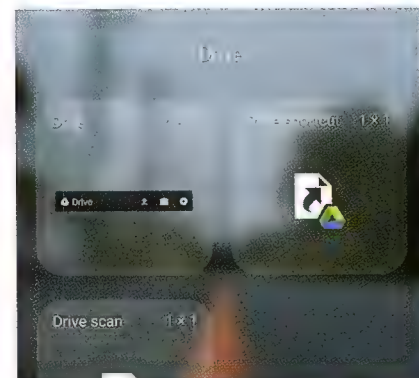
05 UPLOAD DEVICE FILES

Open an app in your device for which you want its content uploaded to Drive. Tap and hold or tick all folders/files you want to upload, tap the Share icon and select 'Drive' to upload.



03 OFFLINE MODE

Tap on the three-dot icon next to any file in your Drive list. Here you can adjust your sharing permissions and see when a file was last modified. Under Offline, flick the switch to on.



06 WIDGETS

Open your Widgets window. Each Google app provides a widget and a shortcut. Drag the Drive widget and some Google app shortcuts to your home screen, creating a mobile Google desktop.

Use Chrome as your desktop

Set up a super-slick desktop in Chrome.

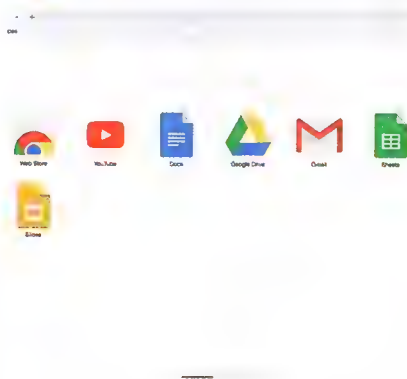
Google is no longer just a search engine – it now offers a collection of high-quality web apps which are now in competition with software such as Microsoft Word, Excel and PowerPoint, as well as a series of other brilliant web apps and services. A web app is just the same as an app you would have on your smartphone or tablet, but it runs through a web browser such as Firefox or Chrome. What can be a little jarring about this transition into web apps is the fact that you are no longer installing a piece of software onto your computer, nor are you opening up files as you

would have done in the traditional way on your computer. Instead, everything is accessed through Chrome, although there is desktop software for Drive, which will locate all of your files into a folder format on your desktop. But as for running something like Google Docs or Sheets, all of this happens within a browser window.

To help ease the transition into making your web browser your new desktop, follow these steps to set up your brand new Chrome-based desktop, offering easy access to all of your most important web apps and sites.

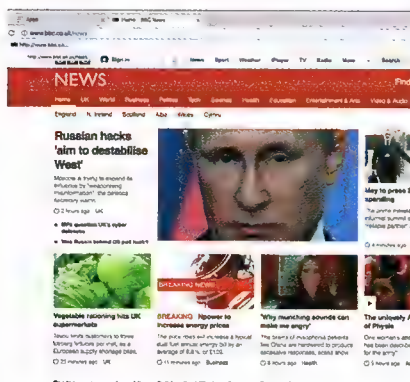


CHROME | SET UP A CHROME-BASED DESKTOP



01 PIN ITEMS FROM SPLASH SCREEN

Open a new tab in Chrome and then click on apps in the top-left corner. In the bottom-right corner will be a link to the Chrome web store where you can add more apps.



03 SET UP YOUR BOOKMARKS

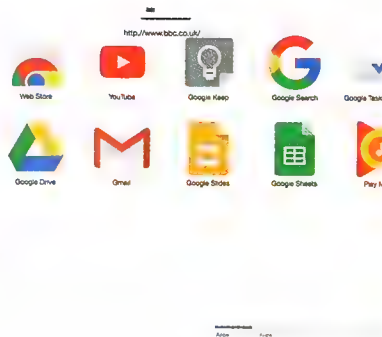
Add secondary sites to your bookmarks, which you may not want to open on startup but want quick access to. Click and drag the icon next to a site URL into the space below it to create a bookmark.

Startup pages:



02 STARTUP PAGES

From the menu bar, click Chrome → Preferences. Under 'On Start-up', check 'Open a specific page or set of pages'. Then click 'Set Pages'. These pages will automatically open up when you start Chrome.

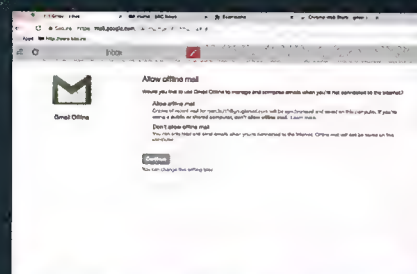


04 ADD SITES TO SPLASH SCREEN

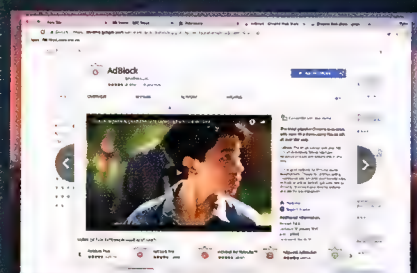
You can save URLs by dragging and dropping onto your splash screen. Now restart Chrome. All previously opened pinned web apps will open and all saved startup pages will display.

Improving Chrome with extensions

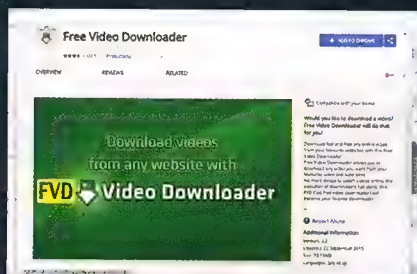
Some extensions you won't be able to do without



01 Gmail Offline lets you read and respond to emails offline by storing emails as they are received on your computer. Emails written offline are delivered when online.



02 Ad Block prevents pop-ups and spam sites from disturbing you. It also has a great selection of filter options and the ability to hide sections of certain pages.



03 FVD makes downloading video files through your browser easy. Once a video is detected on a webpage, click the FVD widget and a download link appears.



GOOGLE TIPS

Organisation

Harness the power of Google's online services to help get your life in order.

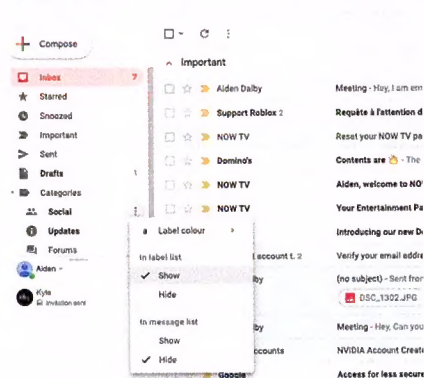
Getting organised with Google's huge array of web, mobile and tablet apps goes way beyond syncing your emails and calendars and setting up a few bookmarks for your favourite sites. It is now possible to shift your entire life onto Google, utilising its free services to better manage everything from everyday tasks, to the running of your business, and keeping up to date with your stocks. The key is how you implement these into your life.

A lot of what's available through Google's web browser, Chrome, is not always hugely advertised. There are a lot of great unknown tricks and tips for speeding up your workflow and streamlining the way you and your devices communicate with Google.

In the following tutorials you will learn how to make the most out of Google Drive; discover how to treat Chrome as your new desktop, giving you access to all your files, documents and

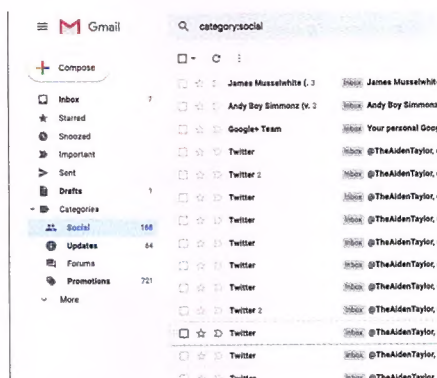
favourite websites instantly, as well as a selection of tips on the various Chrome extensions that are available; and learn some great time-saving techniques for organising all of your online and offline content. Whether you want to play music from the cloud or receive phone notifications on your desktop, in these guides you are going to find out just how organised you can get.

EMAIL | ORGANISE YOUR INBOX WITH GOOGLE'S CATEGORY SYSTEM.



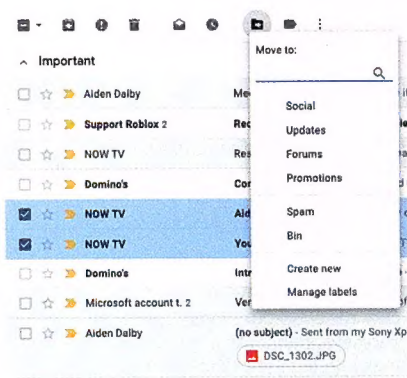
01 DISPLAY CATEGORIES

In Gmail, hover over the navigation menu to the left of the page. Scroll down to Categories and click the more icon to the right of a category. Under 'In Label List', check Show.



02 BROWSING CATEGORIES

By default there are four categories: Social, Updates, promotions and Forum. Google will automatically allocate your emails to categories, depending on their content.



03 MOVING EMAILS

If an email has been added to a category that isn't meant for, click the checkbox next to it. Then click 'Note Category Name'. Or click the tag icon and reallocate somewhere else.

Organise your mail with Gmail's new tabs

Meet the new-look inbox, packed with features to help filter your messages.

The Gmail service is constantly receiving tweaks – and we've never been happier with how it works. One of the most useful features revolves around tabs, though strangely this addition isn't instantly apparent. To access it you have to open the Settings menu (via cog icon) – here you'll find the option to 'Configure inbox', which is where the magic happens.

You can add various categories of tabs to the top of your primary inbox and all the emails relating to these will be automatically filtered into their respective tabbed inbox, instantly de-cluttering your primary inbox. This makes it far easier to find certain emails and never miss the important ones. You can also move messages between tabs if you find something filed incorrectly and the system is intelligent enough to learn from its mistakes and perform better for you over time. If you operate mainly through your primary inbox, Gmail will notify you when you have new mail in the other tabbed categories. These notifications take the form of non-intrusive coloured boxes on the tabs.



Adding themes

If you click on the cog icon in the top-right corner and then choose the Themes option, you'll be able to apply an attractive new theme to your inbox. There are plenty to choose from and they can really add some spice to your interface. You can also adjust further settings by using the links along the top of the window.

The new Gmail

Exploring your new-look Gmail inbox

Your tabs

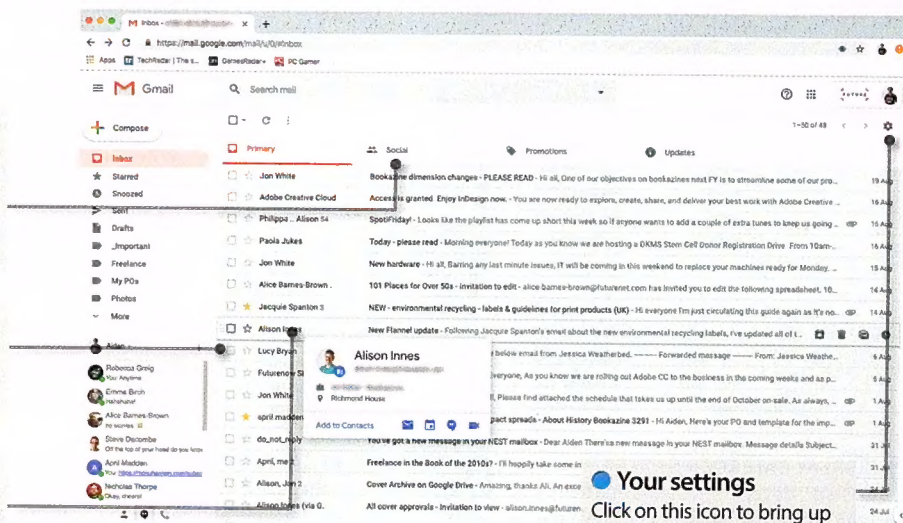
You can set up tabs by clicking on the Settings icon and then choosing the 'Configure inbox' option. Your emails will be divided up into sections, which you can access with these tabs.

Message options

Click the checkbox next to any email and new options allow you to move the message, label it, delete it and more.

Contact options

Hover your mouse over a contact's name and you will see options to send an email, start an Allo chat and more.



Your settings

Click on this icon to bring up options to change the display of your inbox, apply themes and configure your inbox to facilitate the tabs.



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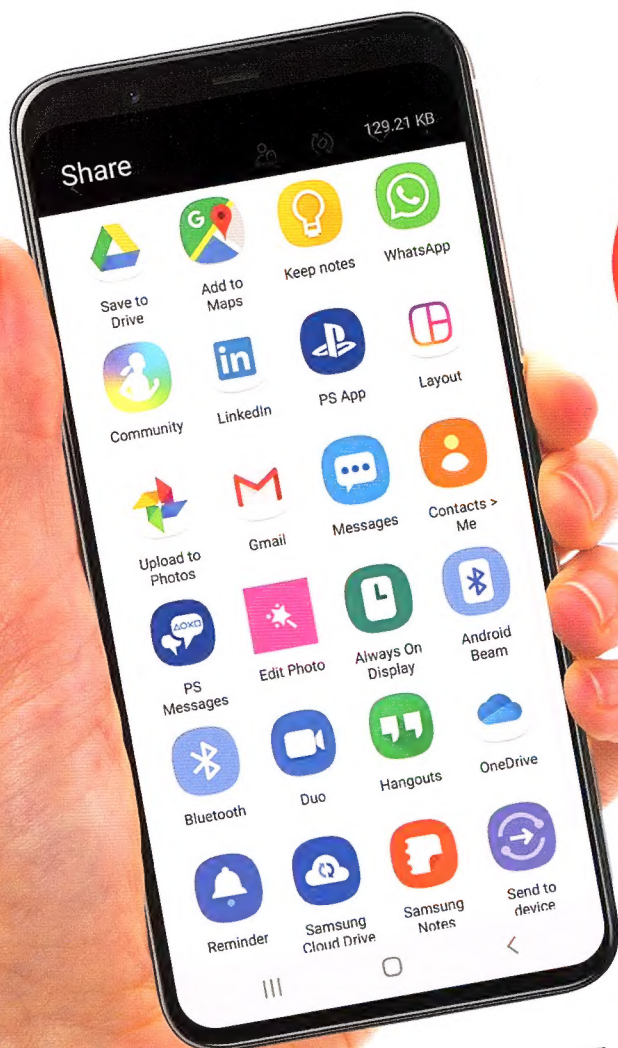
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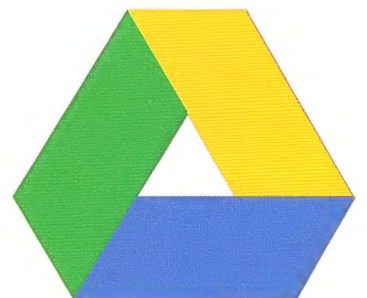
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